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Great Lakes-St. Lawrence Vessel Costing Model

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GREAT LAKES-ST. LAWRENCE VESSEL COSTING MODEL

Research Branch

Canadian Transport Commission

Chris Dineen

Ray Baldwin

Freight Studies Division

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Canadian Transport Commission
15 Eddy St., 15th floor, Ottawa-Hull K1A 0N9

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PREFACE

For many years, the Research Branch has undertaken studies of the transport of grain from Western Canada to Eastern Canadian ports. One purpose of that research was to develop useful tools to better understand the grain transportation system, its cost factors, and its structural relationships.

In 1985, as part of that research program, the Research Branch published a study conducted by Peter Yee in association with York University/University of Toronto Joint Program in Transportation, entitled Estimation of Lake Vessel Costs for Canadian Export Grain. That study presented a costing framework which could be used to estimate the component costs and total trip or contract supply costs relating to a voyage involving a grain forehaul/ore backhaul movement combination that a marine carrier would typically arrange with the respective shippers. The basic cost model incorporated explicit user control of cost and movement elements such as vessel type, origin and destination, capital cost factors, operational variables, and in general, permitted some flexibility so that the effects of a changing environment might be estimated reasonably accurately. The model was implemented in the form of a interactive computer program usable on an IBM PC, or compatible microcomputer.

While the original model allowed sensitivity analyses, it had limitations which have been largely eliminated in an enhanced model. For example, multi-leg voyages, more commodities and a greater set of origin and destination ports are now 'built into' the costing methodology. This report describes the enhancements designed and implemented by the authors, Research Branch staff. The report evaluates a variety of voyage scenarios which serve as examples of the range of costing applications available with the model. Here, as before, the capital charges developed in the report are based on the 1983 cost of new vessels and a current cost of capital rate. The cost data have been updated to 1986 levels where possible. Further, more variables are adjustable than before, thus permitting a user to compare more marine movements and costs with those of modal alternatives.

This report is being published as a working paper to attain a timely dissemination to the specialized reader population interested in the marine trade. Readers should be aware that the enhanced model is now available on request in the form of one microcomputer diskette, in IBM PC 360k byte format (only). Interested readers are invited to send requests, and a blank formatted diskette, to Ray L. Baldwin, A/Chief Agricultural Products, Freight Studies Division, CTC Research Branch, Ottawa K1A-0N9.

Any opinions in this report are those solely of the authors, and are not necessarily the views of the Commission or the Government of Canada.

G. Hariton

G. Hariton
Executive Director
Research Branch

Canada

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CHAPTER I

INTRODUCTION

1.1 Background

The importance of the Great Lakes-St. Lawrence Seaway system as a vital link in the North American transportation network is well known. This system of open water, locks, canals and ports allows for the low cost movement of bulk materials such as grain, iron ore and coal either for export or use by Canadian and U.S. industries in the Great Lakes region. Both economic fluctuations and government regulations have major effects on the operating environment and the vessels that face it. In the period of buoyant economic activity in the late 1970's there was concern over possible capacity limitations for both the laker fleet and the Welland Canal. The recession of the early 1980's alleviated these fears but replaced them with worries about possible bankruptcy for several lake carrier companies. Under government control are such factors as seaway tolls, pilotage requirements and fees, rates for shipping bulk commodities by competing modes, and operating regulations for vessels, all of which affect the cost structure or utilization of the system and hence its viability.

1.2 Vessel Costing Model

The Vessel Costing Model is a computer program designed to estimate the costs of owning and operating lake vessels on the Great Lakes-St. Lawrence Seaway system in the grain, iron ore and coal trades. It was originally developed by Peter Yee in 1985 (see Yee 1985) to study grain shipments out of Thunder Bay (with or without iron ore backhaul) and has recently been expanded to include many additional grain loading and unloading ports and to allow for study of coal voyages. The model incorporates every important factor contributing to vessel cost. The interactive microcomputer program in BASIC allows the user to select cargo, vessel type, route, loading and unloading ports and to vary many of the cost assumptions and parameters for sensitivity analysis. The operation of the program is described in detail in Appendix A.

1.3 Contents of this Report

The organization of the report is as follows: after this Introduction, Chapter 2 describes briefly the grain, grain-iron ore backhaul and coal trades on the Great Lakes-St-Lawrence Seaway system and the vessels engaged therein. Chapter 3 gives a detailed account of the methodology and assumptions employed and fully explains each component of capital cost, operating cost and voyage cost, which sum up to total vessel cost. In Chapter 4, the data base is displayed and in Chapter 5 the results of several selected voyage simulations are presented. Chapter 6 discusses sensitivity analysis and Chapter 7 findings and conclusions. In Appendix A the working of the computer program is detailed and in Appendix B a sample of the complete model output is given.

1.4 Acknowledgements

The authors wish to acknowledge this project benefitted from the contributions made by Peter Lee, who authored the original report and software, and Pierre Sauvé who drafted the first database of lake port/traffic/tariff information for this project. Several sections of descriptive text from the original Yee report have been reproduced here. Interested readers may obtain the Yee report as well by contacting the Commission officer identified in the Preface.

CHAPTER 2

GRAIN, GRAIN-IRON ORE BACKHAUL AND COAL MOVEMENTS ON THE GREAT LAKES-ST. LAWRENCE SEAWAY SYSTEM

2.1 Grain Flows

For Canada the Great Lakes-St. Lawrence Seaway system is a major link in one of the two main grain distribution channels (the second being the rail route to British Columbia ports). For the United States the waterway is much less important — merely an alternative to the Mississippi-Gulf of Mexico route. However, because substantial amounts of American Prairie grain have moved through the system in periods of high congestion on the Mississippi, the Vessel Costing Model allows for study of voyages originating at 4 American ports (Duluth, Toledo, Chicago and Milwaukee) as well as 5 Canadian ports (Thunder Bay, Midland, Goderich, Toronto and Prescott).

In 1985, grain cargoes accounted for 19.4% of tonnage carried on the waterway and, since the average length of haul is long (1935 km), 31.9% of tonne-kilometrage.

Most Canadian grain that passes through the Great Lakes-St. Lawrence Seaway system comes from prairie farms from which it is trucked to elevators and then moved by rail to Thunder Bay. There, grain destined for export is loaded onto lake vessels and shipped to lower St. Lawrence ports (Montreal, Sorel, Trois-Rivières, Québec, Baie Comeau and Port Cartier) or Halifax for transfer to ocean vessels. Some prairie grain moves from Thunder Bay to Great Lakes ports (Midland, Goderich, Port Colbourne, or Prescott) where it may be processed and stored for winter rail shipment to the east coast at "At and East" rates. A small amount of Canadian export grain is loaded directly onto ocean going vessels at Thunder Bay.

Wheat, barley, oats, rye and canola are the most important prairie grains moved. Some Ontario grains such as wheat, corn and soybeans or processed grain products travel from Ontario Great Lakes ports (Midland, Goderich, Toronto or Prescott) to Lower St. Lawrence ports or Halifax.

2.2 Backhaul of Iron Ore

Whenever possible most vessels engaged in the mainline Upper Great Lakes to Lower St. Lawrence grain trade arrange to carry a backhaul of Labrador iron ore from Sept-Îles, Pointe Noire or Port Cartier to steel mills at Hamilton, Ontario or on U.S. Lake Erie or Lake Michigan ports (Cleveland, Ashtabula, Buffalo, Detroit or Chicago). This procedure makes vessel utilization more efficient than for a return voyage in ballast so the cost per tonne of shipping both grain and iron ore is reduced. This backhaul became possible when rich iron ore deposits were discovered in Labrador and usable Mesabi range deposits in the U.S. became depleted. Recently a new upgrading process has made Mesabi ore economically viable once again so both ore sources are being used. A continuing backhaul trade appears to be secure since a large portion of Labrador ore capacity is owned by vertically integrated U.S. steel mills. Of course, the demand for ore fluctuates widely with the state of the economy. The ratio of ore tonnes to grain tonnes moved on the waterway has been as high as .63 in 1975 and as low as .29 in 1982. In 1985, all iron ore shipments accounted for 19.4% of system traffic by tonnage and 24%

by tonne-kilometrage (average haul length 1457 km). About 65% of iron ore tonnage was due to backhaul of Labrador ore.

2.3 Coal

In recent years coal has been the most important cargo on the Great Lakes-St. Lawrence Seaway system in terms of tonnage. In 1985, coal represented 23.2% of total cargo weight but only 11.3% of tonne-kilometrage because the average haul length is rather short (575 km). There are really two distinct coal trades. Thermal coal, i.e., lignite and sub-bituminous is used at Ontario Hydro generating stations at Nanticoke, Lakeview and Sarnia. Most of it originates in the northeastern U.S. and is shipped from Lake Erie ports (Toledo, Conneault, Sandusky, Erie and Ashtabula). Some comes from Alberta deposits by rail to Thunder Bay from where it is shipped by lake vessels to the hydro plants.

Metallurgical or bituminous coal is used in steel mills at Hamilton, Nanticoke and Sault Ste. Marie and originates from the same U.S. region as thermal coal. There is some movement of both types of coal to the Lower St. Lawrence region (Montreal).

2.4 Vessels

As of 1985, there were 118 Canadian dry-bulk vessels on the Great Lakes with a combined mid-season cargo capacity of 2.6 million tonnes. These vessels are owned and operated by ten companies, with the three largest being Canada Steamship Lines Inc., Upper Lakes Shipping Limited and Algoma Central Railway, followed by four moderate-sized companies including Misener Transportation, N.M. Paterson & Sons Limited, Carryore Limited and Halco Inc.

Of the 118 dry-bulk vessels, 83 are bulkers and 35 are self-unloaders. Bulkers and self-loaders differ in several respects, but mainly in the method of cargo unloading. Bulkers are designed with one or more cargo holds along the length of the ship, and cargo is loaded and unloaded by on-shore equipment. The equipment could be an overhead crane with a clam-like bracket for coal or a "leg" with a series of buckets on an endless belt from a grain elevator. The self-unloader, on the other hand, has machinery on board so that cargo can be unloaded without on-shore equipment; loading of cargo, however, is poured from above like the bulker. The unloading equipment is quite elaborate, involving belts which convey cargo to the stern and then to the ship's main deck. On the deck, cargo is transferred to another endless belt which runs the length of a boom for unloading. Bulkers and unloaders in the fleet vary in size with lengths of less than 153 metres to approximately 222.5 metres. The large seaway-sized vessels, that is, 222.5 metres long and 23.0 metres wide, accounted for 73 vessels in the 1983 fleet with 49 of these being bulkers and 24 being self-unloaders. In terms of tonnage, the seaway-sized vessels represented 73% of the fleet.

Statistics indicating the type of lake vessels dedicated to the grain/iron ore trade for the most recent year are not available from published sources. However, a study conducted by Gordon C. Shaw in 1982, entitled A Forecast of the Canadian Dry-Bulk Vessel Requirements on the Great Lakes in 1990, provides information on industry practices for 1979. In the study, grain and iron ore trades on the mainline were found to be served almost entirely by bulkers. Of the 762 voyages made that year, bulkers accounted for 744 voyages, while self-unloaders accounted for 18 voyages. More importantly, 428 of the voyages were made by the full seaway-sized bulkers. Clearly,

the full seaway-sized bulkers dominated the grain trade on the mainline. However, in more recent years, self-unloaders have been serving the mainline grain/iron ore trade with increased frequency. This is partly attributed to the recession where the decline in other dry bulk trades has forced the self-unloaders to seek business in the grain trade. As well, there is concern that ore unloading ports in the U.S. will not maintain on-shore facilities.

Coal is carried almost exclusively by seaway-sized self-unloaders due to the lack of unloading facilities at most destination ports.

CHAPTER 3

COSTING METHODOLOGY

3.1 Overview

Modern lake vessels have been chosen for costing rather than older vessels which might represent the average age of the Great Lakes fleet. The reasoning is that new vessels show the costs of moving incremental grain traffic in the most efficient manner possible and that by choosing marginal instead of average costs the problem of deciding on the "average" vessel is eliminated.

The model focuses on costs as borne by the vessel owner-operator rather than market influenced shipping rates. In the long term the two should converge.

Cost accounting methods have been used rather than statistical estimation procedures since the relevant costs are directly observable and data was supplied to Peter Yee by lake carriers for his original study (Yee 1984).

For organizational purposes costs are broken down into 3 main groups: capital charge, operating costs and voyage costs. Each group is described in detail below.

3.2 Vessels

Four types of modern full-sized seaway vessels are used for analysis: lake bulker, lake/ocean bulker, lake self-unloader and lake/ocean self-unloader.

3.3 Capital Charge

To illustrate the method by which the capital cost of a new vessel is spread over its operating life in this model so that both original capital and an allowance for its use are recovered, consider the following situation. Capital expenditure I for a new vessel is incurred in year 0 with subsequent inflows of revenue R_t (t = year 1 to n) each year for the next n years. Consider also that all money streams are measured in current dollars. Further, assume that the residual value of the initial investment is zero at the end of the investment horizon (i.e., in year n) and that the variable cost incurred each year is C_t. Therefore, the cash flow before tax in year t will be $A_t = R_t - C_t$. When taxes are applied, and if no depreciation allowances are permitted, the net cash flow (i.e., net of taxes) can be expressed as $A_t - T_tA_t$ or $(R_t - C_t)(1 - T_t)$; where T_t is the corporation tax rate in year t. However, vessels are permitted under Canadian tax laws to apply depreciation allowances to reduce the taxable income and subsequently the amount of tax paid. Assume for the moment that the lake carrier decides to apply depreciation allowances each year by the amount D_t, then the vessel's taxable income will be $A_t - D_t$ and the amount of tax paid will be $T_t(A_t - D_t)$. The net cash flow (i.e., net of tax) in year t will therefore be $A_t - T_t(A_t - D_t)$.

Under the investment appraisal methods of net present value, yield and annual capital charge, the investment of the vessel will be accepted if the following rules hold:

$$\sum_{t=1}^{t=n} \frac{A_t - T_t(A_t - D_t)}{(1+r)^t} - I = NPV > 0 \qquad (1)$$

$$\sum_{t=1}^{t=n} \frac{A_t - T_t(A_t - D_t)}{(1+r')^t} = I \qquad (2)$$

$$A_t - T_t(A_t - D_t) - \left(\frac{Ir}{(1+r)^n - 1} + Ir \right) = \text{surplus}_t \qquad (3)$$

Equation (1) is the net present value method, and the investment is accepted if at the firm's specified cost of capital r, the NPV is positive. Equation (2) is the yield method and the investment is accepted if the internal rate of return r' exceeds the firm's specified cost of capital r. Equation (3), however, is the annual capital charge method and the investment is accepted if at the firm's specified cost of capital r, the annual net cash flow exceeds the capital charge (i.e., resulting in a surplus_t). In simplistic terms, the annual capital charge method, which is also known as the annuity method of discounting, recognizes that there are two costs associated with the use of capital: depreciation and interest on the capital employed. Specifically, the method aims at charging depreciation on a sinking fund basis such that the full capital invested in the vessel will be recovered at the end of the vessel's life; also, interest is charged on the initial capital each year until the end of the investment period. The terms representing depreciation and interest costs in equation (3) are $Ir/((1 + r)^n - 1)$ and Ir respectively.

An important feature of the capital charge method is its relationship with the investment appraisal methods of net present value and yield. It can be shown that the present value of surplus discounted at the same cost of capital r as used in equation (1) will equate to NPV, that is:

$$\sum_{t=1}^{t=n} \frac{\text{surplus}_t}{(1+r)^t} = NPV \qquad (4)$$

Also, if the same cost of capital as the yield method is used, that is, r', surplus_t will become zero and, hence, NPV in equation (4) will equate to 0. This means that when the cost of capital is r', the annual capital charge method is similar to the net present value and yield methods. The significance of this relationship is that while the capital charge method will lead to the same investment decision as the other two methods of appraisal under specific conditions, it also provides a convenient way of spreading the capital cost annually over the life of the vessel. This is particularly useful because it helps to determine the level of net cash flows to be required each year to cover the capital charge for a given cost of capital. Assuming that the firm specifies the cost of capital to be k, then the algebraic form for this condition is the following:

$$\left[A_t - T_t(A_t - D_t)\right] - \left[\frac{Ik}{(1+k)^n - 1} + Ik\right] = 0 \tag{5}$$

Equation (5) is obtained by substituting r by k in equation (3). The term surplus is reduced to zero and the equation simply states that the annual net cash flows (first term in square brackets) less the annual capital charge (second term in square brackets) will be equal to zero at the specified cost of capital k.

Equation (5) is also key to the computation of the long-run average cost of the vessel, for it represents all of the financial resources employed to produce the vessel's unit of output. The equation takes on clearer meaning when the annual cash flow is substituted by the revenue and cost variables (i.e., $A_t = R_t - C_t$) as shown below:

$$(R_t - C_t) - T_t(R_t - C_t - D_t) - \left[\frac{Ik}{(1+k)^n - 1} + Ik = 0\right]$$

$$R_t = \left[\frac{Ik(1+k)^n}{(1+k)^n - 1} - T_t D_t\right]\left[\frac{1}{1-T_t}\right] + C_t \tag{6}$$

Equation (6) expresses the revenue required each year as a function of the firm's cost of capital k, price of the vessel I, depreciation allowances D_t, corporate tax rate T_t, and the variable cost C_t which is comprised of the vessel's operating cost OC_t and the voyage cost VC_t. As this expression indicates the level of revenue required in the long run, it also provides guidance on rate setting for vessels, especially those on long-term contracts. In practice, whether the vessel will be able to secure the required freight rates under real conditions will depend on competitive forces in the lake shipping market.

A particularly important variable in Equation (6) is the depreciation allowances D_t. Under Canadian tax laws, lake carriers whose vessels are built and registered in Canada can elect to apply the fast capital cost allowances to write-off the vessel in the first four years of operation at the rate of 1/6, 1/3, 1/3 and 1/6 for each of the respective years. However, this is only permissible if the lake carrier generates sufficient taxable income. In the situation where the lake carrier's vessels are built overseas or do not generate sufficient taxable income, Canadian tax laws will allow the application of depreciation allowances at the maximum rate of 15% of the undepreciated cost of the vessel each year. This effectively means that the lake carrier will be able to recover his initial capital much more quickly with the fast write-off than he would otherwise, and in terms of Equation (5), D_t will assume values of 0 in year 5 and thereafter. To smooth out the fast capital cost allowances, D_t (t=1 to 4) is discounted to the present day and distributed by the annuity method over the life of the vessel. This is shown as follows:

$$R_t\left\{\frac{Ik(1+k)^n}{(1+k)^n - 1} - \left[\frac{T_1 I}{6(1+k)} + \frac{T_2 I_2}{3(1+k)^2} + \frac{T_3 I}{3(1+k)^3} + \frac{T_4 I}{6(1+k)^4}\right]\left[\frac{k(1+k)^n}{(1+k)^n - 1}\right]\right\}\left\{\frac{1}{1-T_t}\right\} + OC_t + VC_t$$

Assuming that the annual corporate tax rate T_t is constant over time, and it takes on the value T (commonly at 50%) then the equation becomes:

$$R_t = \left\{ \frac{Ik(1+k)^n}{(1+k)^n - 1} \right\} \left\{ 1 - \frac{T}{6(1+k)} - \frac{T}{3(1+k)^2} - \frac{T}{3(1+k)^3} - \frac{T}{6(1+k)^4} \right\} \left\{ \frac{1}{1-T} \right\} + OC_t + VC_t \quad (7)$$

In the case where the fast depreciation allowances are not applicable, the declining balance method of depreciation allowances being practised by some lake carriers is also included as an alternative. Letting q be the rate of decline, Equation (5) under this condition becomes the following:

$$R_t = \left[\frac{Ik(1+k)^n}{(1+k)^n - 1} - TIq(1-q)^{t-1} \right] \left[\frac{1}{1-T} \right] + OC_t + VC_t \quad (8)$$

An important clarification is necessary at this point, and it concerns the firm's cost of capital k. Since the money streams are expressed in current dollars, k is expressed in nominal terms. The nominal cost of capital k, in this instance, represents the lake carrier's opportunity cost of capital (i.e., the expected rate of return offered by equivalent risk investments) as well as the side effects of financing the project. One method of measuring k is the weighted cost of capital approach which requires information on the mix regarding debt and equity, the cost of the different sources of capital and the risk associated with the venture. The formula can be stated as follows:

$$k = r_d(1-T)(L/I) + r_e(E/I)$$

where: r_d = cost of debt
T = corporate tax rate
L = debt capital
I = capital investment
r_e = cost of equity
E = equity capital

The application of this formula in its most rigorous form requires the variables in it to be similar to the firm as a whole. The formula gives the correct cost of capital only for projects that are like the firm undertaking them; that is, the formula works for the "average" project that is neither safer nor riskier than the average of the firm's existing assets. A departure from the "average" project would lead to a decrease or increase in the firm's debt ratio and, hence, a change in the firm's specified cost of capital. This condition becomes a problem when, in the case of the lake carrier, the cost of capital specified for the new vessels is not representative of the firm as a whole. As lake carriers are largely private corporations, which are not required to reveal financial statements as public companies do, it is not possible to verify whether new investments in vessels would affect the company's debt ratio. If this restrictive condition is not met, the weighted cost of capital obtained from the formula will only be approximately correct.

Finally, it is also important to clarify the interpretation of the term annual capital charge in equations (7) and (8). As discussed previously, the strict definition of annual capital charge at the firm's specified cost of capital k is $k(1 + k)^n/((1 + k)^n - 1)$. As this term excludes the tax effects, it would be more convenient for the purpose of illustrating the results of vessel costing to include them with capital charge. The tax-adjusted annual capital charge is, therefore, employed throughout in the computation and presentation of vessel costs.

3.4 Operating Costs

This category accounts for the expenses incurred in manning, maintaining, insuring and managing the vessel. It excludes capital charges, which are discussed above, and cost items such as bunker fuel, Seaway tolls, etc., which are discussed later on under voyage costs. Specifically, operating costs include the following:

- Crew Wages (CW)
- Repairs and Maintenance (RM)
- Stores and Supplies (SS)
- Insurance (IN)
- Administration (AD)

Lake carriers provided these costs for each of the selected types of ships, and they represent practices for the 1983 navigation season. They have since been updated to 1986 values using inflation factors. For the purpose of this analysis these costs are normalized to a daily basis. Each of the cost items is the sum of many parts: for instance, Stores and Supplies will include cabin supplies, laundry, mooring cables, chandlery, etc., while Insurance will cover hull and machinery, protection and indemnity, etc.

Using the above cost components, the annual operating cost of the vessel in year t is expressed as:

$$OC_t = \left[(CW)(E_1^t)\right] + \left[(RM)(E_2^t)\right] + \left[(SS)(E_3^t)\right] + \left[(IN)(E_4^t)\right] + \left[(AD)(E_5^t)\right] \quad (9)$$

Note that E1 to E5 are nominal cost escalators for the respective operating cost components and the resultant costs are, therefore, expressed in current dollars. Equation (9) is also expressed on a per diem basis by dividing it by the length of the operating season (ONS) as follows:

$$\left[\frac{OC_t}{ONS}\right] = \left[(CW)(E_1^t) + (RM)(E_2^t) + (SS)(E_3^t) + (IN)(E_4^t) + (AD)(E_5^t)\right]\left[\frac{1}{ONS}\right] \quad (10)$$

3.5 Voyage Cost

Voyage cost represents the cost incurred by a vessel in making a voyage exclusive of capital charge and operating costs. It is comprised of four principal components: port charges, seaway tolls, pilotage fees, and fuel costs. Voyage cost is essentially a function of the chosen logistics of the vessel. For the purpose of this model, a grain voyage is defined as a vessel moving grain downbound from a grain loading port to one of the Great Lakes or lower St. Lawrence grain-unloading ports, combined with a return upbound movement to the origin. The nature of the backhaul defines the three different classes of voyage routing:

1. Grain Shuttle: a voyage having no backhaul. The ship is empty for the entire return movement to the origin.

2. Canadian Steel Mills Backhaul: a voyage having a backhaul of iron ore from one of the lower St. Lawrence iron ore-loading ports (Port Cartier, Pointe Noire, or Sept-Iles) for unloading at Canadian steel mills in Hamilton before proceeding empty to the origin.

3. U.S. Steel Mills Backhaul: a voyage having a backhaul of iron ore from one of the lower St. Lawrence iron ore-loading ports to one of the U.S. iron ore-unloading ports on the lower Great Lakes (Buffalo, Ashtabula, Cleveland, Chicago, or Detroit) before proceeding empty to the origin.

In view of the different ports of call a vessel may make, a set of reference ports is assumed for each of the three voyage routing classes as follows:

1. Grain Shuttle: Thunder Bay -Quebec -Thunder Bay

2. Canadian Mills Backhaul: Thunder Bay -Quebec -Sept-Iles - Hamilton -Thunder Bay

3. U.S. Mills Backhaul: Thunder Bay -Quebec-Sept-Iles - Cleveland -Thunder Bay

These routings constitute the base case, but alternative ports can be selected where necessary. In this particular instance, Quebec has been selected as the grain- unloading port for all three routes because it is a busy grain port and because of its geographic location, rather than for any other consideration (e.g., relatively larger grain tonnage handled at Port Cartier, etc.). As Quebec is located between the up river grain port of Montreal and the downriver grain port of Port Cartier, Quebec is assumed to be a representative port of call for unloading grain in the lower St. Lawrence River. The base case routes are, therefore, used to serve as a benchmark for the comparison of vessel costs. A coal voyage is defined as a vessel moving coal from one of six loading ports to one of six unloading ports and then returning empty to the origin. For coal voyages there is no base case.

The basic equation for voyage cost is:

VOYAGE COST = PORT CHARGES + SEAWAY TOLLS + PILOTAGE FEES + FUEL COST

Each of the four principal cost components in the above equation can be further subdivided, and this is discussed below.

3.5.1 Port Charges

Port charges are those costs incurred by the shipowner while the ship is in port, exclusive of the cost of fuel consumed in port. Port charges are sub-divided into two components, as follows:

$$\text{PORT CHARGES} = \text{HARBOUR DUES} + \text{HANDLING COST}$$

Harbour dues are charges imposed on a vessel when it enters a harbour, applied as a rate per gross registered ton:

$$\text{HARBOUR DUES} = (h_i + h_j + h_k + h_l)\text{GRT}$$

where:

$h_{i,j,k,l}$ = Harbour charges per gross registered ton at ports i, j, k and l

GRT = Gross registered tonnage of vessel

Harbour dues are currently applied only at some of the grain and ore ports on the mainline grain/iron ore routes. For the Canadian ports, harbour dues are applied at those ports designated as either National Harbours (Montreal, Halifax, Trois Rivieres, Quebec and Sept-Iles) or Public Harbours (Sorel, Midland, Goderich, Baie Comeau and Pointe Noire). No harbour dues are charged at the U.S. ports.

Handling is a catch-all term which represents the charges imposed on the shipowner for services associated with the loading/unloading of a vessel when in port. Such charges cover the following items: port agency, stevedoring at Thunder Bay, elevator overtime at Thunder Bay, berthage, and towing. The exact cost of handling for a given voyage will depend on the size of the vessel and on the particular private grain elevators and ore docks chosen for loading and unloading, each of which will have a different fee schedule. A highly structured cost formula for handling has not been developed, so handling cost enters the computation as a simple average value for the type of routing chosen, i.e., grain shuttle or iron ore backhaul. As will be seen later, this is not an exceedingly large item.

3.5.2 Seaway Tolls

Seaway tolls for transit of the Welland Canal and the Montreal-Lake Ontario (MLO) section are paid by the shipowner and shipper to the St. Lawrence Seaway Authority. Seaway tolls are comprised of GRT tolls, cargo tolls, and lockage fees. Currently, the shipowner pays the GRT tolls and lockage fees, while the shipper pays the cargo tolls. The GRT tolls are charges applied to the gross registered tonnage of the transiting vessel. The cargo tolls are charges applied to the tonnage of cargo carried by the vessel, and the tolls vary with the type of cargo. GRT and cargo tolls are applied on each of the Welland and MLO sections. Lockage fees, on the other hand, are applied only on the Welland. The lockage fee is currently structured as one flat rate per lock transited for a loaded ship and a lower flat rate per lock for a ship in ballast. There are eight locks on the Welland Canal.

The total seaway tolls for a given voyage vary with the size and capacity of the vessel. For a given vessel and grain load, the total seaway tolls depend on whether or not there is an iron ore backhaul. Considering the grain shuttle, the total seaway tolls for one voyage can be calculated using the following equation:

Seaway Tolls = GRT Tolls + Cargo Tolls + Lockage Tolls

GRT Tolls = $2(GRT_W + GRT_{MLO})GRT$

Cargo Tolls = $(CARGO_{gw} + CARGO_{gMLO})$GRAIN TONNES

Lockage Fees = 8(LOCK LOADED + LOCK EMPTY)

where:

GRT_W, GRT_{MLO} = GRT Toll on Welland and MLO sections, respectively ($/gross registered ton)

GRT = Gross registered tonnage of vessel

$CARGO_{gw}$ = Cargo toll on grain on Welland Canal ($/tonne)

$CARGO_{gMLO}$ = Cargo toll on grain on MLO Section ($/tonne)

GRAIN TONNES = Tonnes of grain carried downbound

LOCK LOADED = Charge per lock on Welland Canal for a loaded vessel ($/lock)

LOCK EMPTY = Charge per lock on Welland Canal for a vessel in ballast ($/lock)

For an iron ore backhaul or coal voyage, the total seaway tolls are similarly calculated by including an additional term in the equation for cargo tolls to account for tolls levied on the iron ore or coal cargo.

3.5.3 Pilotage Fees

Pilotage fees are paid by the shipowner to a pilotage authority for the services of a pilot in specified sections of the Great Lakes/St. Lawrence Seaway. The mainline grain movement passes through the jurisdiction of two pilotage authorities: the Great Lakes Pilotage Authority and the Laurentian Pilotage Authority. The Great Lakes Pilotage Authority has jurisdiction throughout the Canadian Great Lakes and on the St. Lawrence River as far downstream as the St. Lambert Lock in Montreal, taking in the entire St. Lawrence Seaway. The Laurentian Pilotage Authority begins its jurisdiction at the St. Lambert Lock and terminates at the Gulf of St. Lawrence. Both jurisdictions have established compulsory pilotage areas. The Great Lakes Pilotage Authority currently exempts Canadian-registered vessels with experienced masters from compulsory pilotage. However, no such exemption is granted by the Laurentian

Pilotage Authority. Therefore, Canadian ships must pay the published pilotage fees between Montreal and Les Escoumins, Quebec.

The pilotage fee charged between Montreal and Les Escoumins is a function of two factors: the dimensions of the vessel and the length of time the ship is underway with a licensed pilot aboard. The size of the vessel is measured in terms of a "pilotage unit," and the time under pilotage is measured in terms of a "time factor," as defined below. For the section of the St. Lawrence between Montreal and Quebec, the current pilotage fee is given by:

Pilotage fee ($) = 16.94 PU + 8.38TF

PU = Pilotage Unit

$$= \frac{\text{(Tariff Length) (Beam) (Depth)}}{855}$$

where Tariff Length is the lesser of 7.5 (Beam) and Overall length

TF = Time Factor

= (Draft of Ship) x (Time in hours that ship is underway under pilot)

Note: all measurements in metres.

Between Quebec and Escoumins, the rates are lower, so that the pilotage charge here is given by:

Pilotage Fees ($) = 10.75 PU + 6.22 TF

It is apparent from the above formulae that the pilotage fees incurred during a voyage increase as the voyage proceeds further downriver from Montreal.

3.5.4 Fuel Cost

Bunker fuel is consumed by a vessel during a voyage when it is in port and when it is navigating (although the consumption rate during navigation is about 10 times higher). Fuel cost is, therefore, simply the following:

FUEL COST = FUEL COST IN PORT + FUEL COST IN NAVIGATION

In port, the ship consumes marine diesel, a light fuel, to operate its generator. In navigation, besides consuming additional marine diesel, the ship burns a heavy fuel to power its main engine. This is the typical technology for a newly built vessel. Variations do exist, and for example, some new lake self-unloaders operating on the Great Lakes/Seaway run exclusively on marine diesel. Furthermore, the grade of heavy fuel used to drive main engines differs between particular vessels. In general,

the amounts of the two types of fuel consumed in port and navigation by a vessel during a voyage are calculated as:

$$MD_{PORT} = \overline{MD}_{PORT}(PT_i+PT_j+PT_k+PT_l)$$

$$MD_{NAV} = \overline{MD}_{NAV}(\text{Days Navigating})$$

where:

MD_{PORT} = Short Tons of Marine Diesel consumed in port

$\overline{MD}_{PORT}$ = Consumption rate of Marine Diesel in port (Short Tons/day)

$PT_{i,j,k,l}$ = Time in days spent in port of call i, j, k, l

$\overline{MD}_{NAV}$ = Consumption rate of Marine Diesel in navigation (Short tons/day)

MD_{NAV} = Short Tons of Marine Diesel consumed in navigation

$$HEAVY_{NAV} = \overline{HEAVY}_{NAV}(\text{Days Navigating})$$

where:

$HEAVY_{NAV}$ = Short Tons of Heavy Fuel consumed in navigation

$\overline{HEAVY}_{NAV}$ = consumption rate of Heavy Fuel in navigation (Short Tons/day)

The total fuel cost of the voyage is finally expressed as the following:

$$\text{FUEL COST(\$)} = P_{MD}(MD_{PORT} + MD_{NAV}) + P_{HEAVY}(HEAVY_{NAV})$$

where:

P_{MD}, P_{HEAVY} = prices of Marine Diesel and Heavy Fuel in $/Short Ton.

3.5.5 Transit Times

The methods used to calculate port and navigation times in the above equations require clarification. The time spent by a vessel in a given port is subdivided into two components: waiting time and loading/unloading time. Waiting time represents the time spent by a vessel standing in the harbour waiting for a berth, shifting between berths, and waiting in the berth for loading/unloading equipment to become available. Observed waiting time in 1986 varies considerably between ports, running on average at 0.7 days. Loading/unloading time is the time during which a vessel is actually being loaded or unloaded (dock working time), and this is a function of the size of cargo load of the ship and the loading/unloading capacity of the shore-based equipment at the port (and of the vessel's own unloading equipment in the case of a self-unloader).

In equation form the time spent in a given port by a given ship (in days) is calculated as:

$$\text{PORT TIME} = \text{PORT WAITING TIME} + \text{CARGO CAPACITY}/\text{PORT RATE}$$

where:

CARGO CAPACITY = tonnes of cargo carried by the vessel
PORT RATE = average rate of loading or unloading at the port (tonnes/day)

Navigation time (in days) for a single voyage is calculated using the following expression:

$$\text{Navigation Time} = \text{Distance}_{LW}/V_{LW} + \text{Distance}_{EW}/V_{EW} + 2T_{WELLAND} + 2T_{MLO}$$

where:

Distance_{LW} = distance over which vessel sails loaded in open water (mi.)

Distance_{EW} = distance over which vessel sails empty in open water (mi.)

V_{LW} = speed of vessel sailing loaded in open water (mi./day)

V_{EW} = speed of vessel sailing empty in open water (mi./day)

$T_{WELLAND}$ = time required for a single one-way transit of the Welland Canal (days)

T_{MLO} = time required for a single one-way transit of the Montreal-Lake Ontario Section (days)

In the above definitions, "open water" is taken to include all sections of the mainline grain/ore routes, with the exception of the Welland Canal and the MLO section. In the Welland and MLO, the presence of locks and narrow ship channels or canals imposes low speed limits on vessels such that the transit time is basically independent of a vessel's open water speeds. Therefore, the transit times on the Welland and MLO enter the navigating time equation as simple terms which represent average observed transit times (currently at 0.5 days f or the Welland and 1.0 days for the MLO section). Naturally, Seaway tolls and transit times are adjusted to reflect the particular voyage under study.

The use of two different open water vessel speeds for loaded and empty movements reflects observed carrier voyage information. This voyage data indicates that vessel operating speeds differ by about 10% between loaded and empty movements in open water, while fuel consumption rates show somewhat less variation between the two conditions. The implication is that many ships are being operated at a consistent

engine speed, which results in constant fuel consumption but higher sailing speed for the vessel when in ballast. It is assumed that this practice will not change materially in future and, therefore, the technical relationship between vessel speed and fuel consumption has not been incorporated in the costing formulae.

3.6 Vessel Cost Formulae

Based on the foregoing, the vessel cost formulae can now be stated as follows:

General Formula*:

Vessel Cost = Capital Charge + Operating Cost + Voyage Cost

Vessel Cost Per Voyage V in year t

$$VC_{v,df,t} = \left[\frac{Ik(1+k)^n}{(1+k)^n-1}\right]\left[1-\frac{T}{6(1+k)}-\frac{T}{3(1+k)^2}-\frac{T}{3(1+k)^3}-\frac{T}{6(1+k)^4}\right]$$

$$\left[\frac{1}{1-T}\right]\left[\frac{VT_{vt}}{ONS_t}\right]+\left[(CW)(E^t_1)+(RM)(E^t_2)+(SS)(E^t_3)\right.$$

$$\left.+(IN)(E^t_4)+(AD)(E^t_5)\right]\left[\frac{VT_{v,t}}{ONS_t}\right]$$

$$+HD_{v,t}+HC_{v,t}+ST_{GRT,t}+ST_{v,c,t}+ST_{v,l,t}$$

$$+(a_{v,t})(PU)+(b_{v,t})(TF_{v,t})$$

$$+P_{MD}(MD_{v,port}+MD_{v,nav})E^t_{MD}$$

$$+(P_{heavy})(Heavy_{v,nav})(E^t_{heavy})$$

or

$$VC_{v,ds,t}=\left[\frac{Ik(1+k)^n}{(1+k)^n-1}-TIq(1-q)^{t-1}\right]\left[\frac{1}{1-T}\right]\left[\frac{VT_v}{ONS_t}\right]$$

$$-\left[(CW)(E_1^t)+(RM)(E_2^t)+(SS)(E_3^t)\right.$$

$$\left.+(IN)(E_4^t)+(AD)(E_5^t)\right]\left[\frac{VT_{v,t}}{ONS_t}\right]$$

$$+HD_{v,t}+HC_{v,t}+ST_{GRT,t}+ST_{v,c,t}$$

$$+ST_{v,l,t}+(a_{v,t})(PU)+(b_{v,t})(TF_{v,t})$$

$$+P_{MD}(MD_{v,port}+MD_{v,nav})E^t_{MD}$$

$$+(P_{heavy})(Heavy_{v,nav})(E^t_{heavy})$$

Annual Vessel Cost for Voyage V in Year t

$$AVC_{v,df,t}=VC_{v,df,t}\left[\frac{LNS_t}{VT_{v,t}}\right]$$

or

$$AVC_{v,ds,t}=VC_{v,ds,t}\left[\frac{LNS_t}{VT_{v,t}}\right]$$

where:

$VC_{v,df,t}$	=	Vessel Cost for Voyage V with fast depreciation allowances in year t
$VC_{v,ds,t}$	=	Vessel Cost for Voyage V with slow depreciation allowances in year t
$AVC_{v,df,t}$	=	Annual Vessel Cost for Voyage V with fast depreciation allowances in year t
$AVC_{v,ds,t}$	=	Annual Vessel Cost for Voyage V with slow depreciation allowances in year t
I	=	Purchase Price of the Vessel

k	=	Weighted Cost of Capital of the firm
q	=	Declining balance depreciation rate
T_t	=	Corporation tax rate in year t
$VT_{v,t}$	=	Days per Voyage V in year t
ONS_t	=	Annual Operating days
LNS_t	=	Lake Navigation Season in year t
CW	=	Crew Wages in base year
RM	=	Repairs and Maintenance in base year
SS	=	Stores and Supplies in base year
IN	=	Insurance in base year
AD	=	Administration in base year
$E_{1..5}$	=	Cost Escalators for CW, RM, SS, IN and AD, respectively
$HD_{v,t}$	=	Harbour dues per Voyage in year t
$HC_{v,t}$	=	Handling Cost per Voyage V in year t
$ST_{GRT,t}$	=	GRT toll paid by carrier to Seaway Authority
$ST_{v,c,t}$	=	Cargo toll paid by shipper to Seaway Authority for Voyage V in year t
$ST_{v,l,t}$	=	Lockage fee paid by carrier for Voyage V in year t
PU	=	Pilotage Unit
TF	=	Pilotage Time Factor
$a_{v,t}$	=	Charge per Pilotage Unit for Voyage V in year t
$b_{v,t}$	=	Charge per Time Factor for Voyage V in year t
P_{md}	=	Price per short ton of marine diesel in base year
P_{heavy}	=	Price per short ton of heavy fuel in base year
$MD_{v,nav}$	=	Marine Diesel consumption in port for Voyage V
$MD_{v,nav}$	=	Marine Diesel consumption while navigating in Voyage V
$HEAVY_{v,nav}$	=	Heavy Fuel consumption while navigating in voyage V
E_{md}	=	Marine diesel cost escalator

E_{heavy}	=	Heavy fuel cost escalator
t	=	Number of years from the base year
n	=	Economic life of the vessel

3.7 Cost Allocation Formula

For vessels carrying grain on the shuttle with no backhaul, the full cost of the vessel is assigned to the grain cargo. In the case of the grain/Canadian steel mills and grain/U.S. steel mills, where the backhaul of iron ore is involved, the matter is less straightforward. Industry uses the cost of vessel time as a measure of how its resources are used and, consequently, how to price its services. Therefore, following this practice, vessel cost is assigned to grain or iron ore for the period of time when the vessel is laden with either cargo. Furthermore, when the vessel is empty and is positioning itself for the next cargo load it assigns its cost to that cargo. Therefore the vessel cost allocation method is formulated as follows:

$$GCT_{v,df,t} = \left[(GTP_v + GTL_v) \frac{VC_{v,df,t}}{VT_{v,t}} \right] \left[\frac{1}{VCC} \right]$$

or

$$GCT_{v,ds,t} = \left[(GTP_v + GTL_v) \frac{VC_{v,df,t}}{VT_{v,t}} \right] \left[\frac{1}{VCC} \right]$$

and

$$ICT_{v,ds,t} = \left[ITP_v + ITL_v) \frac{VC_{v,df,t}}{VT_{v,t}} \right] \left[\frac{1}{VCC} \right]$$

or

$$ICT_{v,ds,t} = \left[ITP_v + ITL_v) \frac{VC_{v,ds,t}}{VT_{v,t}} \right] \left[\frac{1}{VCC} \right]$$

where:

$GCT_{v,df,t}$ = Vessel cost per tonne of grain for voyage V with fast depreciation allowances in year t

$GCT_{v,ds,t}$ = Vessel Cost per tonne of grain for voyage V with slow depreciation allowances in year t.

$ICT_{v,df,t}$ = Vessel cost per tonne of iron ore for voyage V with fast depreciation allowances in year t.

$ICT_{v,ds,t}$ = Vessel cost per tonne of iron ore for voyage V with slow depreciation allowances in year t.

GTP_v = Vessel time positioning for grain voyage V

GTL = Vessel time laden with grain in voyage V

ITP_v = Vessel time positioning for iron ore

ITL_v = Vessel time laden with iron ore

VCC = Cargo capacity of vessel

$VC_{v,df,t}$ = Vessel cost for voyage V with fast depreciation allowances in year t.

$VC_{v,ds,t}$ = Vessel cost for voyage V with slow depreciation allowances in year t

$VT_{v,t}$ = Days per voyage in voyage t

CHAPTER 4

DATA BASE

4.1 Information Sources

The three lake carriers--Algoma Central Railway, Canada Steamship Lines Limited and Misener Transportation--were the primary sources of information for Yee's original study. The data were compiled for each specific type of vessel by the lake carriers, and these were subsequently aggregated according to vessel type to represent industry practices for the lake bulker, lake/ocean bulker, lake self-unloader and lake/ocean self-unloader participating in the Canadian grain trade.

Other sources from published and private material also supported the data base. These include Greenwood's Guide to Great Lakes Shipping, Canadian Ports and Seaway Directory, and Gordon C. Shaw's 1979 Dry-Bulk Fleet Data Base.

4.2 Data Base

The data is based on information for the four types of modern vessels selected for analysis. It is organized into seven components as follows:

- Vessel Dimension and Performance
- Purchase Price and Financial Information
- 1986 Annual Operating Cost
- Voyage Routings
- 1986 Port Characteristics
- 1986 Seaway Tolls and Pilotage Rates
- 1986 Handling Costs and Fuel Prices

The details are shown in Exhibits 4.1 to 4.7. It should be noted that in Exhibit 4.2, a distinction is made between domestic construction and overseas construction for the lake/ocean bulker. This distinction is made in order to illustrate the differences in the cost of purchasing and financing vessels built in Canada and overseas. The data presented are based on two actual lake/ocean bulkers supplied by the lake carriers. However, the two vessels are not identical and therefore, some precision will be lost in the cost comparison of lake/ocean vessels.

Exhibit 4.1

Vessel Dimension and Performance

	Bulker		Self-Unloader	
	Lake	Lake/Ocean	Lake	Lake/Ocean
Principal Dimension:				
- Length Overall (Metres)	222.5	222.5	222.5	222.5
- Breadth Moulded (Metres)	23.0	23.0	23.0	23.2
- Depth Moulded (Metres)	12.8	14.6	14.2	15.2
Draft:				
- Midsummer Draft (Metres)	7.92	7.92	7.92	7.92
- Ballast Draft (Metres)	6.00	6.00	6.00	6.00
Capacity:				
- Gross Registered Ton	20,200	21,500	22,600	24,700
- Cargo Capacity (Tonnes)	27,500	24,800	26,300	24,800
Operating Speeds:				
- Loaded in Open Water (Knots)	10.5	11.5	10.5	10.5
- Ballast in Open Water (Knots)	11.5	12.0	12.0	12.0
Rate of Self-Unloading (Tonnes/h)	-	-	5,000	5,000
Fuel Consumption Rates (Tonnes/Day):				
- Marine Diesel in Port	1.9	2.5	2.0	2.3
- Marine Diesel in Navigation	4.9	2.5	20.3	2.3
- Marine Diesel when Self-Unloading	-	-	-	20.0
- Heavy Fuel in Navigation	13.5	19.5	-	20.0
Crew Complement	24	22	28	29
Annual Operating Days	260	360	260	360

Exhibit 4.2

1983 Vessel Purchase Price and Financial Information

	Bulker		Self-Unloader	
	Lake	Lake/Ocean	Lake	Lake/Ocean
Purchase Price:				
°Domestic Construction[1]	$29,000,000	$30,000,000	$36,000,000	$39,000,000
or				
°Overseas Construction[2]	-	$42,500,000	-	-
Financing Arrangement:[3]				
°Domestic Construction				
-% Financed by Debt	80%	80%	80%	80%
-% Financed By Equipty	20%	20%	20%	20%
-Cost of Debt	Prime Rate + 1%	Prime Rate + 1%	Prime Rate + 1%	Prime Rate + 1%
-Cost of Equipty	18% p.a.	18% p.	18% p.a.	18% p.a.
or				
°Overseas Construction				
-% Financed by Overseas Debt	-	80%	-	-
-%Financed by Equity Domestic Debt	-	20%	-	-
-Cost of Overseas Debt	-	8 1/2% p.a. over 8 years	-	-
-Cost of Domestic Debt	-	9% p.a.	-	-
Capital Cost Allowance:				
°Domestic Construction	Fast CCA or Declining Balance	Fast CCA or Declining Balance	Fast CCA or Declining Balance	Fast CCA or Declining Balance
or				
°Overseas Construction	-	Declining Balance		-
Expected Rate of Return on Capital After Tax	9%-12%	9%-12%	9%-12%	9%-12%
Corporate Tax Rate	50%	50%	50%	50%
Economic Life	25 years	25 years	25 years	25 years

1 Net of shipbuilding subsidies of 20 percent.
2 No import duties.
3 Cost of equipty of 18 percent represents carriers' equity for average investments.

Exhibit 4.3

1986 Annual Operating Cost

	Bulker		Self Unloader	
	Lake	Lake-Ocean	Lake	Lake-Ocean
Crew Wages	1,227,000	1,557,000	1,431,000	2,051,000
Repairs and Maintenance	470,000	693,000	516,000	756,000
Stores and Supplies	175,000	263,000	219,000	324,000
Administration	234,000	251,000	248,000	274,000
Insurance	321,000	425,000	380,000	506,000
TOTAL	2,427,000	3,189,000	2,794,000	3,911,000
Annual Operating Days	260	360	260	360
Annual Cost Per Day	$ 9,334	$ 8,858	$ 10,746	$ 10,863

Exhibit 4.4

Voyage Routings - Grain-Iron Ore

Base Case and Alternatives*

	Voyage Type		
	Grain Shuttle	Canadian Mills Backhaul	U.S. Mills Backhaul
Grain Loading Port	Thunder Bay (Duluth, Toledo, Chicago, Milwaukee, Midland, Goderich, Toronto, Prescott)	Same	Same
Grain Unloading Port	Quebec (Montreal, Sorel, Trois-Rivières, Baie Comeau, Port Cartier, Midland, Goderich, Pt. Colbourne, Prescott, Halifax)	Same	Same
Iron Ore Loading Port	-	Sept-Îles (Port Cartier, Pointe Noire)	Same
Iron Ore Unloading Port	-	Hamilton	Cleveland (Buffalo, Ashtabula, Chicago, Detroit)

*Base case ports are underlined, alternatives are in brackets.

Coal Voyages**

Coal Loading Ports	Coal Unloading Ports
Thunder Bay	Nanticoke
Toledo	Hamilton
Commeault	Sarnia
Sandusky	Sault Ste. Marie
Erie	Lakeview
Ashtabula	Montreal

**No "base case" is used for coal voyages. The loading and unloading ports are selected as desired.

Exhibit 4.5

1986 Port Times and Charges

Port Type and Name	Harbour Dues ($/G.R.T.)	Average Waiting Time (Days)	Average Loading/ Unloading Rate (Tonnes/h)
Grain Loading (I)			
1. Thunder Bay	0	.95	1500
2. Duluth	0	.70	1700
3. Toledo	0	.70	1100
4. Chicago	0	.10	1300
5. Milwaukee	0	.70	800
6. Midland	0.0347	1.0	1000
7. Goderich	0.0347	1.0	1000
8. Toronto	0	1.0	1000
9. Prescott	0	1.0	1000
Grain Unloading (J)			
1. Montreal	0.0201	2.00	1800
2. Sorel	0.0347	1.20	1100
3. Trois Rivières	0.0201	1.50	1300
4. Quebec	0.0201	0.85	1500
5. Baie Comeau	0.0347	0.90	1400
6. Port Cartier	0	0.70	1600
7. Midland	0.0347	1.0	1000
8. Goderich	0.0347	1.0	1000
9. Pt. Colbourne	0	1.0	1000
10. Prescott	0	1.0	1000
11. Halifax	0.0201	1.0	1000
Iron Ore Loading (K)			
1. Port Cartier	0	0.50	4000
2. Pointe Noire	0.0201	0.30	4300
3. Sept-Îles	0.0201	0.90	3300
Iron Ore Unloading (L)			
1. Hamilton	0	0.25	1150
2. Buffalo *	0	0.20	0
3. Ashtabula	0	0.35	2500
4. Cleveland	0	0.15	3400
5. Chicago	0	0.10	2000
6. Detroit	0	0.20	1000

Exhibit 4.5 (continued)

1986 Port Times and Charges

Port Type and Name	Harbour Dues ($/G.R.T.)	Average Waiting Time (Days)	Average Loading/ Unloading Rate (Tonnes/h)
Coal Loading (M)			
1. Thunder Bay	0	1.0	5453
2. Toledo	0	1.0	1845
3. Commeault	0	1.0	6985
4. Sandusky	0	1.0	3175
5. Erie	0	1.0	1361
6. Ashtabula	0	1.0	6350
Coal Unloading			
1. Nanticoke	0	1.0	0
2. Hamilton	0	1.0	0
3. Sarnia	0	1.0	0
4. Sault Ste. Marie	0	1.0	0
5. Lakeview	0	1.0	0
6. Montreal	0.0201	2.0	0

Note: Unloading rate for coal unloading ports is irrelevant since only self-unloaders serve the coal trade in this model.

*Buffalo has no shore-based unloading equipment for iron ore (requires self-unloaders).

Exhibit 4.6

1986 Seaway Tolls and Pilotage Rates

Seaway Tolls	
Welland Canal	
° GRT ($/gross reg. ton)	0.08
° Grain Cargo ($/tonne)	0.36
° Ore Cargo ($/tonne)	0.36
° Coal Cargo ($/tonne)	0.36
° Lockage with Cargo ($/lock)	290.00
° Lockage in Ballast ($/lock)	215.00
MLO Section	
° GRT ($/gross reg. ton)	0.08
° Grain Cargo ($/tonne)	0.52
° Ore Cargo ($/tonne)	0.85
° Coal Cargo ($/tonne)	0.85
Pilotage Rates (Compulsory Pilotage)	
Montreal-Quebec	
° Pilotage Unit Charge ($/Pilotage Unit)	16.94
° Time Factor Charge ($/Time Factor)	8.38
Quebec-Escoumins	
° Pilotage Unit Charge ($/Pilotage Unit	10.75
° Time Factor Charge ($/Time Factor)	6.22

Exhibit 4.7

1986 Handling Costs and Fuel Prices

Handling Costs (includes Stevedoring, Elevator Overtime, Port Agency Fees, Berthage Charges, Tug Fees)		
Average for Grain Shuttle ($/voyage)	=	27,300
Average for Ore Backhaul ($/voyage)	=	32,000
Average for Coal Voyage ($/voyage)	=	15,000
Fuel Prices ($/Short Ton)		
° Marine Diesel	=	201
° Heavy "Mix" Fuel		
- for lake bulker	=	132
- for lake/ocean bulker	=	137
- for lake self-unloader	=	132
- for lake/ocean self-unloader	=	165

CHAPTER 5

VOYAGE SIMULATIONS

In this chapter the methodology described in Chapter 3 and the data base shown in Chapter 4 are used to simulate some typical grain and coal voyages using the 4 types of vessel described above.

5.1 Assumptions

The assumptions and data employed for this analysis are based entirely on information compiled for 1986. The data base has been described in Chapter 4 and is shown in Exhibits 4.1 to 4.7. However, several clarifications are necessary at this point.

First, all vessels are assumed to be built in Canada, and the corporations owning them would be able to generate sufficient cash flows (either from shipping or other corporate ventures) to utilize the fast capital cost allowance. Since the vessels were constructed domestically, they qualified for shipbuilding subsidies. The subsidy rate applicable to these vessels was set at 20% of the capital cost of the vessel, as the vessels were ordered before July 1, 1980 (vessels ordered after this date qualify for a 9% subsidy and after mid-1985 no subsidy will be in effect).

Second, the weighted cost of capital after tax is estimated at 9.7%, which is within the 9% to 12% expected rate of return on investment after tax reported by the carriers. The calculations are shown in Exhibit 5.1, and the method is based on the weighted cost of capital formula described in Chapter 3. The determinants of weighted cost of capital are derived partly from lake carrier information and partly by judgement. The nominal cost of debt, which is assumed to be 9% per annum, is based on the judgement that short-term interest rates in the long run will eventually decline due to disinflationary forces in the North American economies. This assumes that inflation in the long term will average at 6% per annum and that real interest rates will be 3% per annum. The cost of equity reported by carriers is 18 percent per annum, but this figure reflects the opportunity cost of equity for the company's average investment. As the financing of new vessels are now highly leveraged (i.e., 80% of capital cost of vessel is financed by debt), the risks are expected to be inherently greater. Hence, a risk premium of 70% is judged to be appropriate, and this is applied to obtain a marginal cost of equity of 30.5% for the project. Therefore, the weighted cost of capital after tax is estimated at 9.7% per annum. As illustrated these rates can be altered according to the analyst's perception of financing arrangements. The computer program developed for the model provides the flexibility for changing these assumptions.

Third, the backhaul movement involving iron ore will be fully loaded for each voyage. This is based on the reasoning that the vessel's voyage logistics would be organized to avoid partial loads. Hence, where a vessel is contracted to ship x tonnes of grain and y tonnes of iron ore per year, when $x>y$, the vessel will organize its logistics with a combination of grain shuttle trips (empty backhaul) and fully loaded iron ore backhaul trips to the extent possible.

Exhibit 5.1

Weighted Cost of Capital for Canadian-Built Ships

	Proportion (1)	Nominal Cost Before Tax (2)	Tax Rate (3)	Cost After Tax (4)=(3)x(2)	Weighted Cost After Tax (5)=(1)x(4)
Debt	.80	9%	50%	4.5%	3.6%
Equipty	.20	30.5%	N/A	30.5%	6.1%
Weighted Cost of Capital					9.7%

Finally, because the lake/ocean vessels have a 360-day navigation season instead of the Seaway season of 260 days, the cost of owning and operating such vessels on the lakes is prorated. This implies that lake/ocean vessels are expected to earn the required revenue in the ocean trade to cover the full costs associated with winter operations, that is, for the additional 100 operating days.

5.2 1986 Vessel Costs for the Mainline Grain Trade

Vessel costs for 1986 for the mainline grain trade are shown in Exhibits 5.2 to 5.4. These exhibits are summaries of the detailed computations, and they are illustrated as an overview. As can be seen, the number of days required per voyage varies between routes as well as between types of vessels. The shortest voyage is the grain shuttle route with empty backhaul, while the longest voyage is the grain/steel mills route involving iron ore backhaul to either Hamilton or Cleveland. Using the lake bulker as a means of comparison, the vessel would take about 14 days for the grain shuttle and approximately 19 days for the grain/steel mills route. The difference in voyage time is mainly attributed to distance and the number of ports of call. However, the marginal difference in voyage time between vessels on the same route is due to the different operating characteristics of the vessel. For a 260-day Seaway navigation season, the vessels would make about 13 to 15 voyages on the grain/steel mills routes, and about 18 to 19 voyages on the grain shuttle route.

Vessel costs also vary by voyages and by types of vessels. As expected, the vessel cost per voyage is higher for the longer grain/steel mills route than the shorter grain shuttle route with empty backhaul. In the case of the lake bulker, vessel cost is estimated at $430,855 for the grain shuttle trip. Vessel cost differences are also visible between types of vessels on the same voyage. Generally, bulkers have lower vessel costs than self-unloaders, and this is mainly explained by the relatively higher capital cost of self-unloaders where expensive unloading equipment is an essential feature. A further distinction can also be observed in the vessel cost of lake and lake/ocean vessels as the latter has consistently lower costs. For example, in the grain shuttle trip the cost per voyage for the lake/ocean bulker is $361,337 which is lower than the lake bulker at

$430,855; similarly, the lake/ocean self-unloader at $448,507 is lower than the lake self-unloader at $506,773. The difference is mainly due to the way annual vessel costs for lake/ocean vessels (with year-round operations of 360 days) have been prorated to the shorter Seaway navigation season. In particular, the annual capital charge for the lake/ocean vessel spread over 360 days; thus making the capital charge associated with seaway navigation lower than the lake vessel operating strictly on 260 days.

Exhibit 5.2

Summary of 1986 Vessel Costs for Grain Shuttle Route

(Thunder Bay - Quebec - Thunder Bay)

	Lake Bulker	Canadian-Built Lake/Ocean Bulker	Lake Self-Unloader	Canadian-Built Lake/Ocean Self-Unloader
Per Voyage				
- No. of Days Required	14.0	13.4	13.8	13.7
- Vessel Cost ($)	430,855	361,337	506,773	448,507
Per Seaway Season				
- No. of Voyages	18	19	18	18
- Vessel Cost ($)	7,755,391	6,865,410	9,121,913	8,073,133
Voyage Time Allocation (Days)				
- Grain	14.0	13.4	13.8	13.7
- Iron Ore	0	0	0	0
Cargo Capacity (Tonnes)	27,500	24,800	26,300	24,800
Vessel Cost per Tonne ($)				
- Grain	15.67	14.57	19.27	18.08
- Iron Ore	0	0	0	0

Exhibit 5.3

Summary of 1986 Vessel Costs for Grain/Canadian Steel Mills Route

(Thunder Bay - Quebec - Sept Îles - Hamilton - Thunder Bay)

	Lake Bulker	Canadian-Built Lake/Ocean Bulker	Lake Self-Unloader	Canadian-Built Lake/Ocean Self-Unloader
Per Voyage				
- No. of Days Required	19.0	18.0	18.0	17.9
- Vessel Cost ($)	588,044	489,623	667,819	591,060
Per Seaway Season				
- No. of Voyages	13	14	14	14
- Vessel Cost ($)	7,644,573	6,854,720	9,349,468	8,274,840
Voyage Time Allocation (Days)				
- Grain	12.1	11.5	11.9	11.9
- Iron Ore	6.9	6.5	6.0	6.0
Cargo Capacity (Tonnes)	27,500	24,800	26,300	24,800
Vessel Cost per Tonne ($)				
- Grain	13.69	12.64	16.76	15.73
- Iron Ore	7.70	7.11	8.63	8.10

Exhibit 5.4

Summary of 1986 Vessel Costs for Grain/Canadian Steel Mills Route

(Thunder Bay - Quebec - Sept Îles - Cleveland - Thunder Bay

	Lake Bulker	Canadian-Built Lake/ Ocean Bulker	Lake Self-Unloader	Canadian-Built Lake/ Ocean Self-Unloader
Per Voyage				
- No. of Days	18.2	17.2	17.8	17.7
- Vessel Cost ($)	578,118	482,979	673,166	596,469
Per Seaway Season				
- No. of Voyages	14	15	14	14
- Vessel Cost ($)	8,093,657	7,244,682	9,424,328	8,350,570
Voyage Time Allocation (Days)				
- Grain	11.1	10.5	10.9	10.8
- Iron Ore	7.1	6.7	6.9	6.9
Cargo Capacity (Tonnes)	27,500	24,800	26,300	24,800
Vessel Cost per Tonne ($)				
- Grain	12.82	11.88	15.61	14.67
- Iron Ore	8.20	7.60	9.98	9.38

The allocation of vessel time and cost to grain and iron ore shipments indicates that grain in all three voyages bears the greatest burden. In the grain shuttle with empty backhaul, grain bears the full cost of the movement. However, grain's share of vessel cost declines when the backhaul movement contains iron ore. Measured on a cost per tonne basis, it can be seen that the cost of moving grain in the shuttle route varies from $14.57 for the bulker to $19.27 for the lake self-unloader. When the vessel is fully loaded with iron ore in the backhaul to steel mills in Hamilton, the cost of moving per tonne of grain falls to a range of $12.64 for the lake/ocean bulker to $16.76 for the lake self-unloader. If the iron ore backhaul is destined for Cleveland instead of Hamilton, the cost of moving per tonne of grain varies from $11.88 for the lake/ocean bulker to $15.61 for the lake self-unloader. Thus, the cost of moving grain downbound is reduced when the backhaul movement is loaded with iron ore.

5.3 Vessel Cost Breakdown and Cost Allocation

Vessel costs summarized in Exhibits 5.2 to 5.4 can be broken down in greater detail to reveal the size and significance of the individual cost items. To simplify the results of the vessel cost breakdown, the lake bulker in the grain/Canadian steel mills voyage is used for the purpose of illustrating the cost breakdown. Exhibit 5.5 shows the individual cost items for the bulker, while Exhibit 5.6 shows similar information on a percentage basis. Capital charge constitutes the most significant cost item, accounting for 47% of the annual total cost of the vessel. This is followed by crew wages, seaway tolls and bunker fuel which account for 15%, 10% and 7% respectively. Also conspicuous is the insignificance of pilotage fees and harbour dues as a percentage of total vessel costs.

The allocation of vessel cost and time to grain and iron ore shipments is shown in Exhibit 5.7. The lake bulker will take 12.1 days for the movement of grain and 6.9 days for the backhaul of iron ore. On this basis, the vessel cost assigned to one tonne of grain and iron ore is $13.69 and $7.70 respectively. Projected costs for 1991, derived using the cost escalators described below in section 6.8 are also shown in the Exhibits.

Additional results for other vessels and routes are shown in Exhibits A.1 to A.15 to A.15 in Appendix A. In general these results show no discernible difference from the trend observed in the lake bulker analysis.

Exhibit 5.5

Lake Bulker Cost per Voyage for Grain/Canadian Mills Route

(Thunder Bay - Quebec - Sept Îles - Hamilton - Thunder Bay = 19.0 days)

	1986 $ per Voyage		1991 $ per Voyage	
Capital Charge		274929		274929
Operating Cost		177363		241853
° Crew Wages	89631		119947	
° Repairs and Maintenance	34333		50446	
° Stores and Supplies	12857		17205	
° Administration	17093		22875	
° Insurance	23449		31380	
Voyage Cost		135753		164722
° Port Charges	32812		43757	
- Port Dues	812		934	
- Handling	32000		42823	
° Seaway Tolls	58079		66789	
- Cargo	47575		54709	
- GRT	6464		7433	
- Lockage	4040		4646	
° Pilotage Fees	6072		6982	
° Bunker Fuel	38790		47194	
TOTAL		588044		681503

Exhibit 5.6

Lake Bulker Annual Cost Distribution for Grain/Canadian Mills Route

(Thunder Bay - Quebec - Sept Îles - Hamilton - Thunder Bay = 13.0 Voyages)

	1986 $ Cost in %		1991 $ Cost in %	
Capital Charge		47		40
Operating Cost		30		35
° Crew Wages	15		18	
° Repairs and Maintenance	6		7	
° Stores and Supplies	2		3	
° Administration	3		3	
° Insurance	4		5	
Voyage Cost		23		24
° Port Charges	6		6	
- Harbour Dues	*		0	
- Handling	5		6	
° Seaway Tolls	10		10	
- Cargo	8		8	
- GRT	1		1	
- Lockage	1		1	
° Pilotage Fees	1		1	
° Bunker Fuel	7		7	
TOTAL		100		100

*Less than one percent.

Exhibit 5.7

Lake Bulker Grain/Iron Ore Allocation, Sailing Distances, and Times for Grain/Canadian Steel Mills Route

Port of Call	Distances (Statute miles)	Time in Port and Sailing	
		Grain (day(s)	Iron Ore (day(s)
Thunder Bay		1.71	
Steaming to Quebec	1372	5.52	
Quebec		1.61	
Steaming to Sept Îles	331		1.04
Sept Îles			1.25
Steaming to Hamilton	858		3.34
Hamilton			1.25
Steaming to Thunder Bay	905	3.26	
TOTALS	3466	12.12	6.88
Percentage of Time		64%	36%
Vessel Cost Allocation - 1986		$376348	$211696
- 1991		$436162	$245341
Vessel Cost per Tonne - 1986		$ 13.69	$ 7.70
(cargo capacity = 27500t) - 1991		$ 15.86	$ 8.92

5.4 Coal Voyages

Vessel costs for 2 representative 1986 coal voyages are shown in Exhibits 5.8 and 5.9. For the longer trips (Thunder Bay - Nanticoke - Thunder Bay, voyage time is about 7.6 days so that 34 such voyages could be made per seaway season. For the shorter trips (Erie - Hamilton - Erie), voyage time is only 4.6 days so that about 55 such voyages could be made per season.

Only 2 vessel types are used here: lake self-unloader and lake/ocean self-unloader. As is the case for the grain voyages, costs are significantly lower for the lake/ocean vessel ($225,734 as opposed to $256,978 per voyage for the Thunder Bay - Nanticoke - Thunder Bay route) because of the vessel's year long navigation season.

A detailed cost breakdown for the Erie - Hamilton - Erie voyage is given in Exhibits 5.10 - 5.12. The lake self-unloader is the vessel used in this example. Exhibit 5.10 shows individual per voyage costs and Exhibit 5.11 percentages of the total. As with grain voyages, capital charge accounts for by far the largest proportion (48%), followed by crew wages (15%) and seaway tolls (10%). Because of the short distance of this voyage, fuel costs are a relatively small proportion (5%) whereas handling costs are significant (9%). The cost per tonne of carrying coal for this route is estimated to be $6.60. Projected costs for 1991 are also shown.

Exhibit 5.8

Summary of 1986 Vessel Costs for Coal Voyage

(Thunder Bay - Nanticoke - Thunder Bay)

	Lake Self-Unloader	Canadian Built Lake/Ocean Self-Unloader
Per Voyage		
- No. of Days	7.6	7.6
- Vessel Cost ($)	256,978	225,734
Per Season Season		
- No. of Voyages	34	34
- Vessel Cost	8,737,257	7,674,972
Total Voyage Distance (Miles)	1616	1616
Cargo Capacity (Tonnes)	26,300	24,800
Vessel Cost per Tonne ($)	9.77	9.10

Exhibit 5.9

Summary of 1986 Vessel Costs for Coal Voyage

(Erie - Hamilton - Erie)

	Lake Self-Unloader	Canadian Built Lake/Ocean Self-Unloader
Per Voyage		
- No. of Days	4.6	4.6
- Vessel Cost ($)	173,622	153,897
Per Seaway Season		
- No. of Voyages	55	56
- Vessel Cost	9,549,217	8,618,204
Total Voyage Disantce (Miles)	244	244
Cargo Capacity (Tonnes)	26,300	24,800
Vessel Cost per Tonne ($)	6.60	6.21

Exhibit 5.10

Lake Self-Unloader Cost per Voyage for Coal Shuttle Route

(Erie - Hamilton - Erie = 4.6 Days)

	1986 $ per Voyage		1991 $ per Voyage	
Capital Charge		83457		83457
Operating Cost		49909		67998
° Crew Wages	25562		34208	
° Repairs and Maintenance	9217		13543	
° Stores and Supplies	3912		5235	
° Administration	4430		5928	
° Insurance	6788		9084	
Voyage Cost		40256		49659
° Port Charges	15000		200078	
- Handling	15000		20073	
° Seaway Tolls	17124		19692	
- Cargo	9468		10888	
- Lockage	4040		4646	
- GRT	3616		4158	
° Bunker Fuel	8132		9893	
TOTAL		173622		201114

Exhibit 5.11

Lake Self-Unloader Annual Cost Distribution for Coal Shuttle Route

(Erie - Hamilton - Erie = 55.0 Voyages)

	1986 $ Cost in %		1991 $ Cost in %	
Capital Charge		48		41
Operating Cost		29		34
° Crew Wages	15		17	
° Repairs and Maintenance	5		7	
° Stores and Supplies	2		3	
° Administration	3		3	
°Insurance	4		5	
Voyage Cost		23		25
° Port Charges	9		10	
- Handling	9		10	
°Seaway Tolls	10		10	
- Cargo	5		5	
- GRT	2		2	
- Lockage	2		2	
° Bunker Fuel	5		5	
TOTAL		100		100

Exhibit 5.12

Coal Voyage - Sailing Distances and Times
Cost Allocation

Port of Call		Distance	Time Day(s)
Erie			1.81
Steaming to Hamilton		122	0.83
Hamilton			1.22
Steaming to Erie		122	0.79
TOTALS		244	4.64
Vessel Cost Allocation	- 1986 - $173622		
	- 1991 - $201114		
Vessel Cost Per Tonne	- 1986 - $6.60		
(Cargo Capacity - 26300 t)	- 1991 - $7.65		

CHAPTER 6

SENSITIVITY ANALYSIS - GRAIN VOYAGES

This chapter investigates the sensitivity of vessel costs to the operating environment. Capital charge, as indicated in the previous chapter, is the single most important component of vessel cost and, therefore, the effects of the underlying factors are examined. Other cost components, particularly crew wages, bunker fuel and seaway tolls also command attention, although their significance is dwarfed by capital charge. The backhaul movement of iron ore on the mainline grain trade also raises the question of how important this movement is to the economics of vessel utilization for the grain/iron ore trade. While this has been discussed in the previous chapter for the full iron ore backhaul movement, there has been no treatment on the effects of a gradual decline in iron ore movements. In addition, Quebec has been chosen as the grain-unloading port for the base case routes, but an alternative port located in the lower St. Lawrence may affect the cost of moving grain and iron ore, and this is investigated. Also, the relative merit of owning and operating a vessel built overseas as opposed to building it in Canada, in terms of cost, is examined; this may provide some insight into why some lake carriers have preferred to build overseas. Finally, the effects of the general economic environment on vessel cost, particularly as they relate to cost pressures in the economy, are explored.

In order to illustrate the results of the sensitivity analysis clearly, only the bulk vessel is examined as this appears to be the most conventional type of vessel used in the grain trade. To further simplify the interpretation of results, the grain/Canadian steel mills route via Hamilton is selected for the analysis. The results apply to costs in 1986 except in the case where cost escalation is involved.

6.1 Backhaul Considerations

As discussed in the previous chapter, the lake bulker on the grain shuttle would assign all of its long-run average cost to grain, thereby resulting a cost per tonne of $15.67. With an iron ore backhaul to Hamilton cost per tonne for grain is reduced to $13.69 and to Cleveland $12.82. As Labrador iron ore shipments to Canadian and U.S. steel mills in the short term have a tendency to fluctuate according to business conditions, the relationship between downbound grain shipments and upbound iron ore shipments will not always be equally balanced. Moreover, as Labrador iron ore shipments to the U.S. steel mills are expected to slow down in the long run while Canadian grain traffic is expected to increase, the balancing relationship is expected to deteriorate. Therefore, the impact of different iron ore backhaul relationships on the cost of moving of grain has been calculated. The results are shown in Exhibit 6.1. It is difficult to forecast the most likely backhaul relationship in future, but if the relationship of three downbound grain shipments to every one upbound iron ore backhaul shipment to Hamilton is assumed to be the trend, the cost of moving one tonne of grain will be $15.18. Similarly, if Cleveland is the iron ore-unloading port instead of Hamilton, the cost of moving grain will be $14.96 per tonne.

Exhibit 6.1

Laker Bulker Cost Per Tonne of Grain as a Function of the Frequency of Iron Ore Backhaul

Frequency of Iron Ore Backhaul (% of Voyages with Backhaul	Weighted Vessel Cost per Tonne of Grain (1986 $)	
	Canadian Steel Mills Backhaul (Hamilton)	U.S. Steel Mills Backhaul (Cleveland)
0 (Grain Shuttle)	15.67	15.67
20	15.27	15.10
33	15.18	14.96
40	14.88	14.53
50	14.68	14.25
60	14.48	13.96
80	14.09	13.39
100 (Backhaul every voyage)	13.69	12.82

6.2 Shipbuilding Subsidies

Canadian built ships ordered after mid-1985 no longer qualify for any shipbuilding subsidy. Without the subsidy, a lake bulker would cost the shipowner $36.25 million instead of $29 million. The capital charge of the vessel on the same voyage would therefore, increase from $274,929 to $343,661 representing an increase of 25%. At the same time, the capital charge would now account for 52% of vessel cost. The cost of moving per tonne of grain will increase to $15.28 from the previous estimate of $13.69 when the subsidy was 20% (for ships ordered before July 1980). This represents a 12% increase in cost per tonne.

6.3 Cost of Debt

The cost of debt has been assumed at 9 percent for the base case computations. This is based on the assumption that short-term interest rates, which peaked in 1981, will continue to decline so that over the 25-year economic life of the vessel, short-term rates will average 9 percent. If inflation returns to levels typical of the late 1970s,i then the cost of debt will be much higher than has been assumed. Assuming that the cost of debt in such an environment is 19.75% per annum, then the weighted cost of capital after tax is estimated to be 14% per annum. This estimate is 4.3% per annum higher than the base case weighted cost of capital of 9.7%. Under this environment, the capital charge for the lake bulker on the grain/Canadian steel mills voyage is estimated to increase to $393,157, which is an increase over the base case estimate of $274,929 by 43%. On a cost breakdown basis, capital charge will account

Exhibit 6.2

Summary of Sensitivity Analysis Results

Grain-Canadian Steel Mills Route

(Thunder Bay - Quebec - Sept-Îles - Hamilton - Thunder Bay)

	Base Case[1]	Backhaul Relationship (33% Iron Ore Backhaul)	No Shipbuilding Subsidy	Cost of Debt (19.75%)	Financial Leverage (100% Debt)	Declining Balance Allowance[2]	Overseas-Built Lake/Ocean Bulker	Cost Escalation to 1991
Capital Charge ($)	274,929 (47%)	N/A	343,661 (52%)	393,157 (56%)	315,050 (50%)	372,014 (54%)	337,876 (53%)	274,929 (40%)
Operating Cost ($)	177,363 (30%)	N/A	177,363 (27%)	177,363 (25%)	177,363 (28%)	177,363 (26%)	159,438 (25%)	241,853 (35%)
Voyage Cost ($)	135,753 (23%)	N/A	135,753 (21%)	135,753 (19%)	135,753 (22%)	135,753 (20%)	135,753 (21%)	164,722 (24%)
Total Vessel Cost ($)	588,044 (100%)	N/A	656,776 (100%)	706,273 (100%)	628,165 (100%)	685,129 (100%)	632,842 (100%)	681,503 (100%)
Vessel Time Allocation (days)								
Grain	12.13	N/A	12.13	12.13	12.13	12.13	11.52	12.13
Iron Ore	6.88	N/A	6.88	6.88	6.88	6.88	6.50	6.88
Vessel Cost per Tonne ($)								
Grain	13.69	15.18	15.28	16.44	14.62	15.94	16.33	15.86
Iron Ore	7.70	7.70	8.60	9.25	8.22	8.97	9.19	8.92
%Change in Cost per tonne over Base Case								
Grain	-	10.9	11.6	20.1	6.8	16.4	20.4	15.9
Iron Ore	-	0	11.6	20.1	6.8	16.4	20.4	15.9

[1]Assumes full iron ore backhaul, 20% shipbuilding subsidy rate, 80% financing by debt, 99% cost of debt per annum, fast capital cost allowances and Canadian-built vessel.

[2]4 percent used.

for 56 percent of the vessel cost as opposed to 47 percent in the base case. Also, the cost of moving per tonne of grain will increase by 21 percent over the base case of $13.69 to $16.44

6.4 Financial Leverage

The base case financing arrangement was set at 80 percent debt and 20 percent equity. However, it is not uncommon for lake carriers to finance new vessels entirely by debt. In this situation, the weighted cost of capital net of tax is not easily calculable as it requires judgement on what premium is appropriate for the risks associated with a fully leveraged investment in Great Lakes shipping. It is recalled that in the base case, where 20% of equity was involved, the risk premium was assumed to be 70%. Since the financing of the vessel is now fully leveraged, the risk premium should be higher. For this reason, the premium for risk-bearing is assumed to be 150% in this analysis. As a result, the weighted cost of capital after tax at a nominal cost of debt of 9% is estimated at 11.25% (i.e., the product of the cost of debt of 9% and the tax rate of 50% factored up by a risk premium of 150%). In other words, the weighted cost of capital after tax of 11.25% reflects a net of tax cost of debt of 4.5% per annum and a premium of 6.75% per annum. Under this financing arrangement, the capital charge of the lake bulker on the grain/Canadian steel mills route is estimated to be $315,050 versus a base case estimate of $274,929. As a percentage of vessel cost the capital charge accounts for 50%. The cost of moving grain is estimated at $14.62 as compared to $13.69 in the base case.

6.5 Depreciation Allowances

The fast capital cost allowance of 1/6, 1/3, 1/3 and 1/6 for each of the four years respectively is commonly acknowledged as one of the most important sources of financing in the lake shipping industry. However, as pointed out previously, this is only advantageous to the financially strong companies with large taxable incomes. Companies without the necessary taxable incomes will not be able to use these allowances. They can, however, elect to write off the cost of the vessel at a rate no faster than 15 percent of the undepreciated cost of the vessel each year. Frequently, this is not even attainable by many carriers and consequently the declining balance method at 4 percent is used instead.

The effect of a slower write-off on the capital cost of the lake bulker is to increase the capital charge. The capital charge on a voyage basis is estimated at $372,014, which is an increase of 35 percent over the base case. As a percentage of vessel cost, capital charge accounts for 54 percent. The effect on vessel cost per tonne is to increase the cost of grain to $15.94 as compared to $13.69 in the base case.

6.6 Overseas Construction

The major advantage in buying overseas vessels for use in the Great Lakes is the attractive financing arrangements. For example, a large part of the capital cost of the vessel can be financed by the host country at low interest rates over a period of time. However, recent legislative changes to import duties on foreign-built vessels, which previously exempted vessels built in Commonwealth shipyards, will now subject all vessels constructed overseas to import duties of 25%. This effectively raises the price of purchasing the overseas-built vessel. Moreover, because the vessel is not built in Canada it will not be entitled to the fast depreciation allowances.

The data employed in evaluating vessel cost under these arrangements is based on the lake/ocean vessel shown in Exhibit 4.2 in Chapter 4. As shown, the new building price to the shipowner is $42.5 million, which is much higher than the cost of either the domestically built lake bulker ($29 m.) or lake/ocean bulker ($30 m.). Also the $42.5 million does not include any import duties as it was ordered and delivered by early 1983. Furthermore, the vessel is financed entirely by debt through overseas and domestic institutions. In estimating the weighted cost of capital net of tax, it has been assumed that after eight years, interest rates would have declined progressively so that the nominal cost of the overseas debt would average 6 1/2 percent over the 25-year economic life of the vessel. For domestic debt, the average nominal cost over the period would be higher at 9 percent. This gives a weighted cost of capital net of tax of 8.75 percent. This is slightly lower than the cost of capital of 9.7 percent estimated for Canadian-built vessels.

Based on these assumptions, it is calculated that the cost of moving grain by the lake/ocean bulker for the grain/Canadian steel mills route is $16.33 per tonne. This estimate is higher than the base case estimate of $13.69 per tonne for the lake bulker. As the calculation is based on the declining balance depreciation allowance, a more comparable estimate is the $15.94 per tonne for moving grain by the lake bulker which employs a similar method of calculating depreciation allowance (see previous section on depreciation allowances). The cost differential in the latter instance is marginal. In view of the new import duties that are now levied on foreign built vessels, it is expected that the cost differential will widen to favour the Canadian built vessel.

6.7 Cost Escalation

Vessel costs will escalate in future. In order to obtain a sense of how these costs are likely to escalate and the impact on the cost of moving grain, the following rates of increase on the individual cost items are assumed over the period 1986-1991:

- Crew Wages - 6% per annum
- Repairs and Maintenance - 8% " "
- Stores and Supplies - 6% " "
- Administration - 6% " "
- Insurance - 6% " "
- Fuel - 4% " "
- Handling costs - 6% " "
- Seaway Tolls - 15% over 5 years
- Pilotage Fees - 15% over 5 years

The above rates reflect an environment of moderate inflation, which is assumed to be around 6% per annum over the next five years. In particular, fuel prices will be subject to the downward pressure in world oil prices and will therefore increase at a rate of 4% per annum, which is lower than inflation. Also, Seaway tolls and pilotage fees, which are subject to government decisions, are assumed to increase by 15% over the five-year period.

By 1991 the vessel cost per voyage will escalate to $681,503 from the 1986 estimate of $588,044. This represents an increase of about 16%. The cost of moving grain by 1991 will increase to $15.86 per tonne, from the 1986 estimate of $13.69.

6.8 Summary

The results of the sensitivity analysis are summarized in tabular form in Exhibit 6.2. It is seen that, based on the assumptions employed, vessel cost is more sensitive to the cost of debt, choice of Canadian or overseas construction (only when compared to the base case), method of depreciation allowances, shipbuilding subsidy, and cost pressure in the economy than to other factors.

It is apparent that capital charge is by far the largest component of the cost of owning and operating lake vessels, as it accounts for about half of the total vessel cost. This clearly demonstrates the capital intensiveness of the lake shipping business and also points out the critical nature of the underlying factors such as new building price, financing arrangements, prevailing interest rate and capital cost allowance in determining the capital charge.

Certain other cost components are important as may be seen in Exhibit 5.6 and other cost distribution tables in Appendix A. Crew wages, seaway Tolls and fuel costs account for approximately 15, 10 and 7 percent of total vessel cost respectively while repairs and maintenance, stores and supplies, administration, handling costs, and insurance account for 2 to 5 percent. Pilotage fees and harbour dues are a negligible percentage of vessel costs. Most of these factors are affected by inflation and/or government policies.

CHAPTER 7

ALTERNATIVE LOADING AND UNLOADING PORTS

The costs per tonne and tonne-mile for a variety of different loading-unloading port combinations for several routes are shown in Exhibits 7.1-7.6.

7.1 Grain Shuttle Route

For the grain shuttle route, as presented in Exhibits 7.1 and 7.2, the results are as one would expect — cost per tonne rises and cost per tonne-mile falls as the length of haul increases, ceteris paribus. This is particularly evident for the four unloading ports east of the St. Lawrence Seaway: Montreal, Québec, Port Cartier and Halifax. For example, with Thunder Bay as the grain loading port, cost per tonne increases from $15.42 for unloading at Montreal to $15.67 for Québec, $17.54 for Port Cartier and $21.67 for Halifax. Cost per tonne-mile falls from .636¢ to .571¢, .521¢ and .486¢ for the same sequence of unloading ports.

When Midland is the grain unloading port, costs per tonne-mile are much higher than for the other destinations because voyage distances are relatively short so the various fixed costs are not spread out over a long haul. Port Colbourne as the unloading port shows costs in the same range as Quebec and Port Cartier for the main line loading ports even though haul length is considerably shorter. This is attributable to the fact that Port Colbourne is located just to the west of the Welland Canal so it represents the longest voyage that can be made without paying seaway tolls. Voyages to lower St. Lawrence ports incur the cost of full seaway tolls and pilotage fees as well.

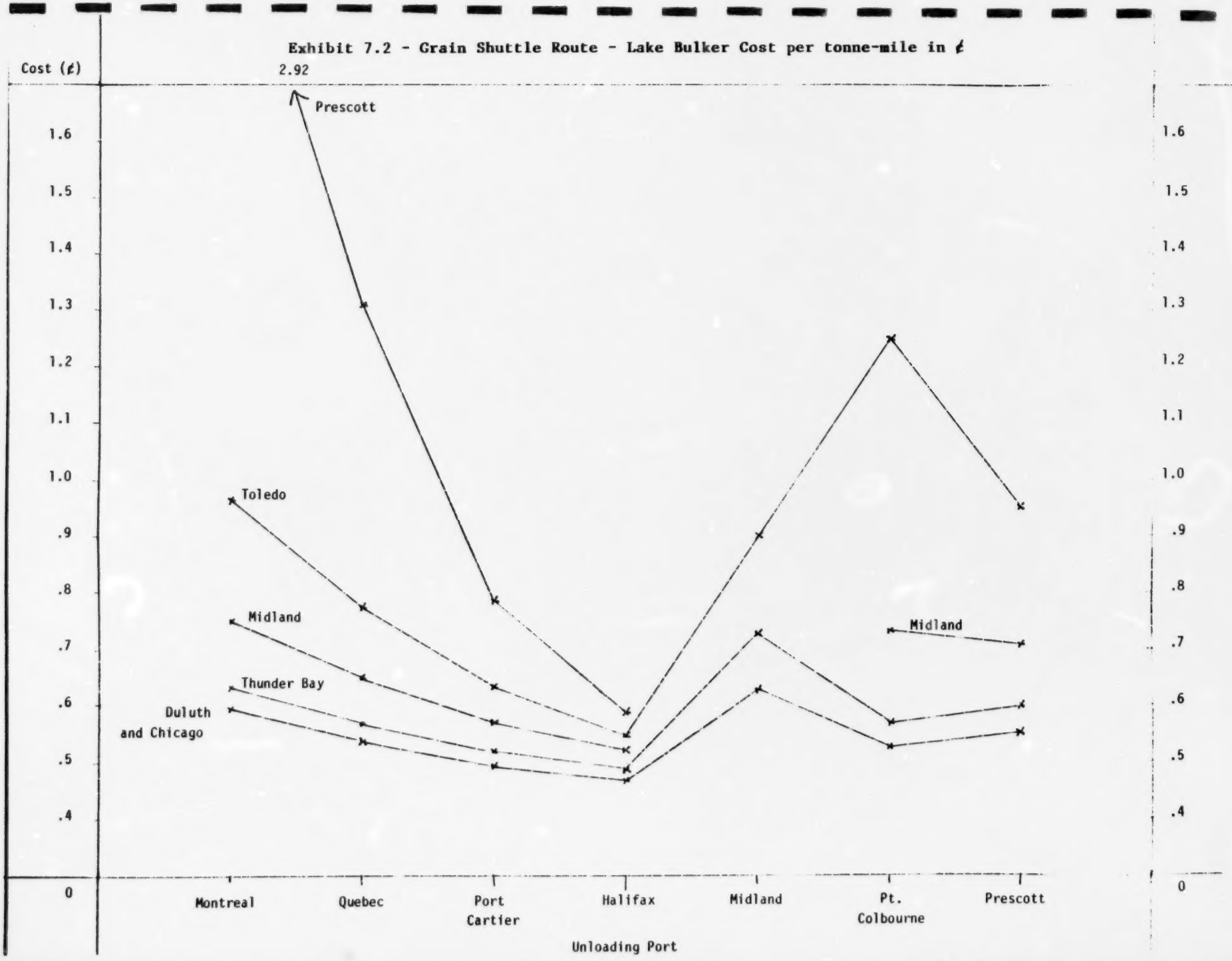
Exhibit 7.1

Cost Comparison for Alternative Loading and Unloading Ports

Grain Shuttle Route Using Lake Bulker

Loading Ports	Unloading Ports						
	Montreal	Quebec	Port Cartier	Midland	Port Colbourne	Prescott	Halifax
Duluth							
Cost/Tonne $	15.90	16.15	18.02	8.33	10.27	13.48	22.15
Cost/ Tonne-mile ¢	.596	.540	.499	.630	.529	.557	.471
Thunder Bay							
Cost/Tonne $	15.42	15.67	17.54	7.85	9.79	13.00	21.67
Cost/ Tonne-mile ¢	.636	.571	.521	.728	.577	.597	.486
Toledo							
Cost/Tonne $	11.55	11.80	13.67	6.87	5.92	9.13	17.80
Cost/ Tonne-mile ¢	.961	.775	.638	.899	1.249	.955	.551
Chicago							
Cost/Tonne $	14.96	15.21	17.08	7.45	9.33	12.54	21.21
Cost/ Tonne-mile ¢	.603	.543	.499	.644	.532	.561	.470
Midland							
Cost/Tonne $	14.07	14.31	16.18	-	8.44	11.65	20.31
Cost/ Tonne-mile ¢	.752	.653	.575	-	.738	.716	.521
Prescott							
Cost/Tonne $	7.19	7.43	9.30	-	-	-	13.43
Cost/ Tonne-mile ¢	2.923	1.313	.784	-	-	-	.590

Exhibit 7.2 - Grain Shuttle Route - Lake Bulker Cost per tonne-mile in ¢



7.2 U.S. Steel Mills Route

Exhibit 7.3 shows cost comparisons for various grain origin-destination pairs on the U.S. steel mills route with iron ore loaded at Sept-Îles and unloaded at Cleveland. Costs per tonne and per tonne-mile are given for both grain and iron ore. Naturally, grain costs are lower for each voyage than for a grain shuttle voyage with the same loading and unloading ports, since costs for each cargo are allocated according to the proportion of total voyage time that the vessel is occupied with that cargo. In general, a longer haul results in lower costs per tonne-mile for both cargoes but the reduction is not proportional because the total lengths of the grain haul and the iron ore haul vary in a complex manner. For example, the voyage Duluth-Montreal-Sept-Îles-Cleveland-Duluth incurs grain cost per tonne-mile of .371¢ and iron ore cost per tonne-mile of .237¢. If Halifax is substituted for Montreal as the grain unloading port, grain cost falls to .353¢ per tonne-mile, a 5% reduction while iron ore cost falls to .182¢ per tonne-mile, a 23% reduction.

For simulations with grain unloaded at Port Cartier, the same port is used for iron ore loading rather than Sept-Îles in order to capture any economies that might result from one less port change than usual. The result is a slight increase in grain cost per tonne-mile and a slight decrease in iron ore cost compared to the Sept-Îles case. The Thunder Bay-Port Cartier-Port Cartier-Cleveland-Thunder Bay voyage shows costs of .415¢ per tonne-mile for grain and .187¢ per tonne-mile for iron ore. If the iron ore loading port is Sept-Îles the costs are .403¢ and .208¢ respectively.

Similar results for voyages with Chicago and Hamilton as iron ore unloading ports are shown in Exhibit 7.4 and 7.5. Note that for the voyage with Chicago as both grain loading port and iron ore unloading port and Port Cartier as both grain unloading port and iron ore loading port the vessel is loaded for the entire run. Costs here are not exactly equal for the two cargoes because of different loading and unloading rates for grain and iron ore at the two ports.

Exhibit 7.3

Cost Comparison for Alternative Loading and Unloading Ports - Grain - U.S.

Steel Mills Route with Iron Ore Loaded at Sept-Îles and Unloaded at Cleveland Using Lake Bulker

Loading Ports	Unloading Ports									
	Montreal		Quebec		Port Cartier*		Midland		Halifax	
	Grain	Iron Ore	Grain	Iron Ore	Grain	Iron Ore	Grain	Iron Ore	Grain	Iron Ore
Duluth Cost										
per Tonne $	13.63	8.71	13.33	8.17	13.54	6.37	9.50	13.11	16.92	8.72
per Tonne-mile ¢	.371	.237	.363	.222	.393	.185	.241	.332	.353	.182
Thunder Bay Cost										
per Tonne $	13.12	8.75	12.82	8.20	14.06	6.32	9.07	13.06	16.36	8.81
per Tonne-mile ¢	.383	.255	.374	.239	.415	.187	.245	.353	.359	.193
Toledo Cost										
per Tonne $	8.99	8.99	8.57	8.57	9.73	6.76	6.52	13.24	12.13	9.15
per Tonne-mile ¢	.408	.408	.389	.389	.472	.313	.223	.452	.365	.275
Chicago Cost										
per Tonne $	12.63	8.78	12.34	8.23	13.31	7.16	8.68	13.02	15.81	8.89
per Tonne-mile ¢	.362	.252	.354	.236	.382	.185	.230	.346	.343	.193
Midland Cost										
per Tonne $	11.69	8.82	11.41	8.26	12.56	6.47	-	-	14.76	9.05
per Tonne-mile ¢	.406	.307	.397	.287	.443	.285	-	-	.369	.226
Prescott Cost										
per Tonne $	8.50	8.85	8.09	8.42	9.20	6.66	-	-	11.77	8.88
per Tonne ¢	.418	.435	.398	.414	.462	.334	-	-	.373	.282

*For voyages with Port Cartier as grain unloading port the iron ore loading port is Port Cartier instead of Sept-Îles.

Exhibit 7.4

Cost Comparison for Alternative Loading and Unloading Ports: Grain-U.S. Steel Mills Route with Iron Ore Loaded at Sept-Îles and Unloaded at Chicago Using Lake Bulker

Grain Loading Ports	Grain Unloading Ports									
	Montreal		Quebec		Port Cartier*		Midland		Halifax	
	Grain	Iron Ore	Grain	Iron Ore	Grain	Iron Ore	Grain	Iron Ore	Grain	Iron Ore
Duluth Cost										
per Tonne $	13.41	11.42	12.95	11.03	14.00	9.33	8.34	14.06	16.59	11.53
per Tonne-mile ¢	.307	.262	.297	.253	.324	.216	.191	.303	.302	.210
Thunder Bay Cost										
per Tonne $	12.90	11.44	12.46	11.05	13.49	9.37	8.86	15.75	16.03	11.61
per Tonne-mile ¢	.313	.277	.294	.268	.331	.230	.202	.358	.306	.221
Toledo Cost										
per Tonne $	10.73	11.63	10.32	11.18	11.47	9.38	8.20	15.92	13.85	11.79
per Tonne-mile ¢	.305	.331	.294	.318	.330	.270	.193	.376	.299	.254
Chicago Cost										
per Tonne $	9.99	11.73	9.60	11.27	10.72	9.51	5.94	16.07	13.26	11.76
per Tonne-mile ¢	.288	.338	.277	.325	.313	.278	.159	.429	.289	.256
Midland Cost										
per Tonne $	11.99	11.52	11.56	11.10	12.55	9.47	-	-	15.01	11.79
per Tonne-mile ¢	.321	.308	.309	.297	.339	.256	-	-	.309	.242
Prescott Cost										
per Tonne $	10.60	11.49	10.29	11.05	11.33	9.27	-	-	13.71	11.68
per Tonne-mile ¢	.305	.331	.294	.318	.331	.270	-	-	.298	.254

*For voyages with Port Cartier as grain unloading port the iron ore is loaded at Port Cartier instead of Sept-Îles.

Exhibit 7.5

Cost Comparison for Alternative Loading and Unloading Ports: Grain-Canadian Steel Mills Route with Iron Ore Loaded at Sept-Îles and Unloaded at Hamilton Using Lake Bulker

Grain Loading Ports	Grain Unloading Ports									
	Montreal		Quebec		Port Cartier*		Midland		Halifax	
	Grain	Iron Ore	Grain	Iron Ore	Grain	Iron Ore	Grain	Iron Ore	Grain	Iron Ore
Duluth Cost										
per Tonne $	14.53	8.17	14.21	7.65	15.28	5.94	10.57	12.41	17.68	8.32
per Tonne-mile ¢	.392	.220	.383	.206	.417	.162	.266	.312	.366	.172
Thunder Bay Cost										
per Tonne $	14.00	8.22	13.69	7.70	14.72	6.01	9.90	12.60	17.10	8.42
per Tonne-mile ¢	.377	.222	.395	.222	.430	.176	.265	.337	.373	.166
Toledo Cost										
per Tonne $	9.91	8.44	9.46	8.06	10.63	6.24	7.45	12.69	12.99	8.66
per Tonne-mile ¢	.442	.376	.422	.359	.483	.283	.251	.427	.386	.257
Chicago Cost										
per Tonne $	13.49	8.27	13.18	7.44	14.19	6.08	9.49	12.58	16.54	8.52
per Tonne-mile ¢	.383	.235	.374	.211	.408	.175	.250	.331	.356	.183
Midland Cost										
per Tonne $	12.53	8.35	12.22	7.81	13.38	6.01	-	-	15.71	8.46
per Tonne-mile ¢	.430	.286	.419	.268	.472	.212	-	-	.389	.209
Prescott Cost										
per Tonne $	7.16	8.40	6.77	7.95	7.88	6.19	-	-	10.37	8.49
per Tonne-mile ¢	.417	.490	.395	.463	.471	.370	-	-	.365	.299

*For voyages with Port Cartier as grain unloading port the iron ore is loaded at Port Cartier instead of Sept-Îles.

7.3 Coal Shuttle Route

In Exhibits 7.6 and 7.7 cost comparisons for coal voyages with different loading and unloading ports are presented. Here the results vary significantly with the length of haul and the sections of the St. Lawrence Seaway transited. For the longest route with Thunder Bay as origin cost per tonne-mile falls as haul length increases for

unloading ports west of the Seaway (Sault Ste. Marie 1.00¢, Sarnia .704¢ and Nanticoke .605¢) but then rises for longer hauls to unloading ports that require traversal of part or all of the Seaway (Hamilton and Lakeview .676 and Montreal .738). The increased costs due to seaway tolls outweigh economies due to longer length. For a short route such as the one with Erie as loading port cost per tonne-mile generally decreases as haul length increases. Thus, a voyage across Lake Erie to Nanticoke costs 4.674¢ per tonne-mile, on through the Welland Canal to Hamilton 2.705¢ or Lakeview 2.723¢, and on through the Montreal-Lake Ontario section of the Seaway to Montreal, 1.426¢. Here the large proportional increases in haul length outweigh the addition to cost of Seaway tolls. The voyages from Erie to Sault Ste. Marie and Sarnia incur no Seaway tolls and cost at .778¢ and 1.165¢ per tonne-mile respectively.

Exhibit 7.6

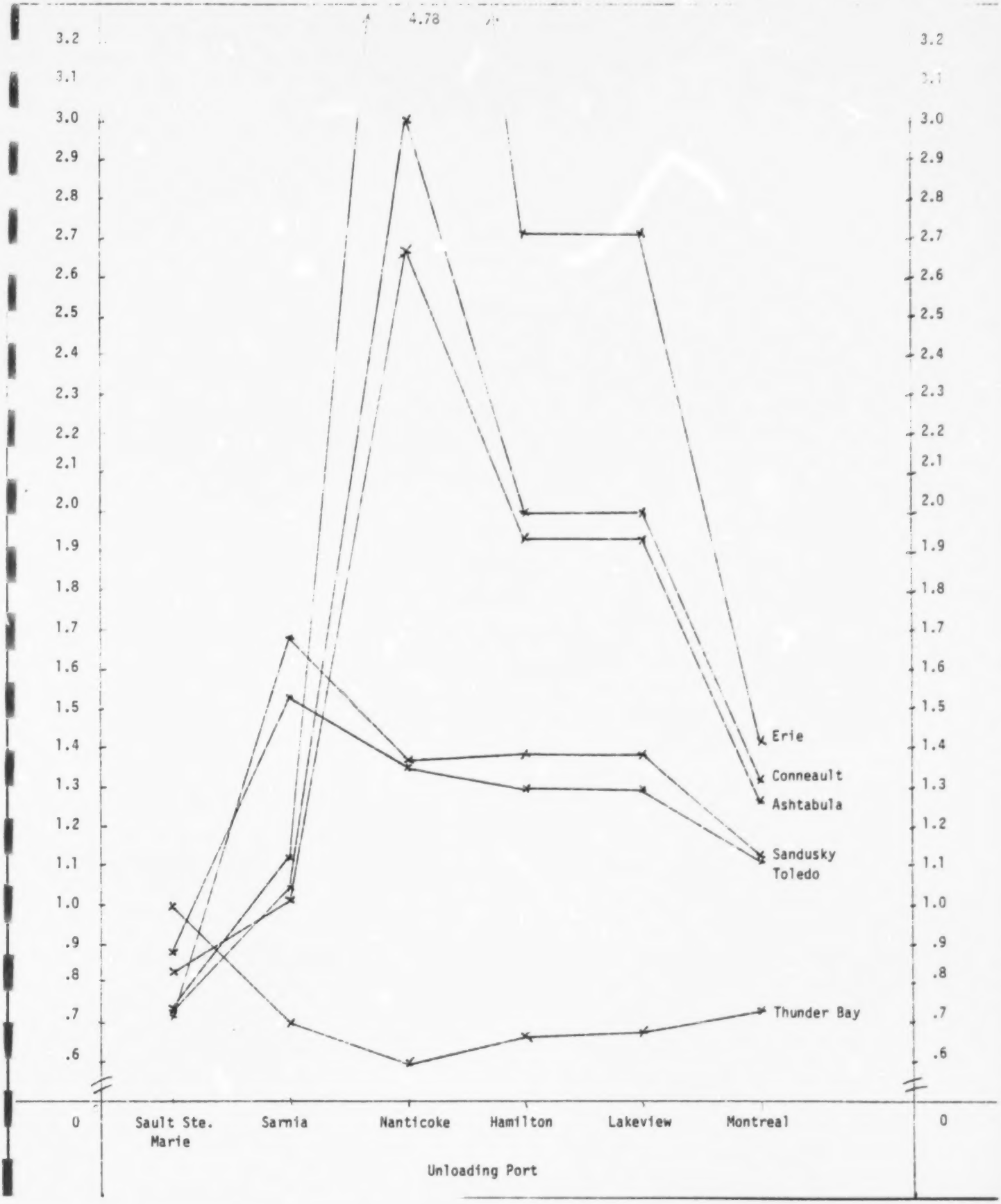
Cost Comparison for Alternative Loading and Unloading Ports

Coal Voyages Using Lake Self Unloader

Loading Ports	Sault Ste. Marie	Sarnia	Nanticoke	Hamilton	Lakeview	Montreal
Thunder Bay Cost						
Per Tonne $	5.46	7.63	9.77	12.23	12.23	17.89
Per Tonne-mile ¢	1.00	.704	.605	.676	.676	.738
Toledo Cost						
Per Tonne $	6.81	4.66	5.30	7.76	7.75	13.41
Per Tonne-mile ¢	.882	1.542	1.332	1.315	1.318	1.114
Sandusky Cost						
Per Tonne $	6.64	4.50	4.89	7.20	7.20	12.94
Per Tonne-mile ¢	.830	1.679	1.336	1.385	1.390	1.119
Ashtabula Cost						
Per Tonne $	7.10	4.97	3.80	6.22	6.21	11.87
Per Tonne-mile ¢	.738	1.15	2.676	1.932	1.941	1.265
Conneault Cost						
Per Tonne $	7.21	5.06	3.70	6.11	6.10	11.76
Per Tonne-mile ¢	.727	1.106	3.033	2.037	2.047	1.287
Erie Cost						
Per Tonne $	8.14	6.01	4.30	6.60	6.59	12.26
Per Tonne-mile ¢	.778	1.165	4.674	2.705	2.723	1.426

Exhibit 7.7

Coal Voyage - Lake Self Unloader Cost per tonne-mile in cents



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Appendix A

VESSEL COSTING RESULTS

Exhibit A.1

Lake Bulker Cost Per Voyage for Grain Shuttle Route

(Thunder Bay - Quebec - Thunder Bay = 14.0 Days)

	$1986 per Voyage		
Capital Charge			203,013
Operating Cost			130,969
° Crew Wages		66,186	
° Repairs and Maintenance		25,352	
° Stores and Supplies		9,494	
° Administration		12,622	
° Insurance		17,313	
Voyage Cost			96,873
° Port Charges		27,706	
- Harbour Dues	406		
- Handling	27,300		
° Seaway Tolls		34,704	
- Cargo	24,200		
- grt	6,464		
- Lockage	4,040		
° Pilotage Fees		3,498	
° Bunker Fuel		30,965	
TOTAL			430,855

Exhibit A.2

Lake Bulker Annual % Cost Distribution for Grain Shuttle Route

(Thunder Bay - Quebec - Thunder Bay = 18.0 Voyages)

	1986 Cost in %		
Capital Charge			47
Operating Cost			30
° **Crew Wages**		15	
° Repairs and Maintenance		6	
° Stores and Supplies		2	
° Administration		3	
° Insurance		4	
Voyage Cost			22
° Port Charges		6	
- Harbour Dues	*		
- Handling	6		
° Seaway Tolls		8	
- Cargo	6		
- grt	2		
- Lockage	1		
° Pilotage Fees		1	
° Bunker Fuel		7	
TOTAL			100

*Less than one percent.

Exhibit A.3

Lake Bulker Sailing Distances and Times and Grain/Iron Ore Cost Allocation for Grain Shuttle Route

Port of Call	Distance (Statute Miles)	Time in Port and Sailing	
		Grain	Iron Ore
		Day(s)	
Thunder Bay		1.71	
Steaming to Quebec	1372	5.52	
Quebec		1.61	
Steaming to Thunder Bay	1372	5.17	
Total:	2744	14.02	0.00
Percentage of Time		100%	0%
Vessel Cost Allocation	1986	$430855	$ 0
	1991	$500208	$ 0
Vessel Cost per Tonne (Cargo Capacity = 27500t)	1986	$ 15.67	$ 0
	1991	$ 18.19	$ 0

Exhibit A.4

Lake Bulker Cost Per Voyage for Grain/U.S. Steel Mills Route

(Thunder Bay - Quebec - Sept-Îles - Cleveland - Thunder Bay = 18.2 Days)

	$1986 per Voyage		
Capital Charge			262,820
Operating Cost			169,551
° Crew Wages		85,686	
° Repairs and Maintenance		32,821	
° Stores and Supplies		12,290	
° Administration		16,341	
° Insurance		22,416	
Voyage Cost			145,747
° Port Charges		32,812	
- Harbour dues	812		
- Handling	32,000		
° Seaway Tolls		68,579	
- Cargo	57,475		
- grt	6,464		
- Lockage	4,640		
° Pilotage Fees		6,072	
° Bunker Fuel		38,284	
TOTAL			578,118

Exhibit A.5

Lake Bulker Annual % Cost Distribution for Grain/U.S. Steel Mills Route

(Thunder Bay - Quebec - Sept-Îles - Cleveland - Thunder Bay = 14.0 Voyages)

	1986 Cost in %		
Capital Charge			45
Operating Cost			29
° Crew Wages		15	
° Repairs and Maintenance		6	
° Stores and Supplies		2	
° Administration		3	
° Insurance		4	
Voyage Cost			25
° Port Charges		6	
- Harbour Dues	*		
- Handling	6		
° Seaway Tolls		12	
- Cargo	10		
- grt	1		
- Lockage	1		
° Pilotage Fees		1	
° Bunker Fuel		7	
TOTAL			100

*Less than one percent.

Exhibit A.6

Lake Bulker Sailing Distances and Times and Grain/Iron Ore Cost Allocation for Grain/U.S. Steel Mills Route

Port of Call	Distance (Statute Miles)	Time in Port and Sailing	
		Grain	Iron Ore
		Day(s)	Day(s)
Thunder Bay		1.71	
Steaming to Quebec	1372	5.52	
Quebec		1.61	
Steaming to Sept-Îles	331		1.04
Sept-Îles			1.25
Steaming to Cleveland	1015		4.29
Cleveland			0.49
Steaming to Thunder Bay	711	2.24	
Totals	3429	11.09	7.07
Percentage of Time		61%	39%
Vessel Cost Allocation	1986	$352652	$225466
	1991	$408823	$261379
Vessel Cost Per Tonne	1986	$ 12.82	$8.20
(Cargo Capacity = 27500t)	1991	$ 14.87	$9.50

Exhibit A.7

Canadian-Built Lake/Ocean Bulker Cost Per Voyage for
Grain/U.S. Steel Mills Route

(Thunder Bay - Quebec - Sept-Îles - Cleveland - Thunder Bay = 17.2 Days)

	$1986 per Voyage		
Capital Charge			186,123
Operating Cost			152,499
° Crew Wages		74,432	
° Repairs and Maintenance		33,129	
° Stores and Supplies		12,573	
° Administration		11,999	
° Insurance		20,317	
Voyage Cost			144,406
° Port Charges		32,864	
- Harbour dues	864		
- Handling	32,000		
° Seaway Tolls		63,352	
- Cargo	51,832		
- grt	6,880		
- Lockage	4,640		
° Pilotage Fees		6,311	
° Bunker Fuel		41,879	
TOTAL			482,972

Exhibit A.8

Canadian-Built Lake/Ocean Bulker Annual % Cost Distribution for Grain/U.S. Steel Mills Route

(Thunder Bay - Quebec - Sept-Îles - Cleveland - Thunder Bay = 15.0 Voyages)

	1986 Cost in %		
Capital Charge			39
Operating Cost			32
° Crew Wages		15	
° Repairs and Maintenance		7	
° Stores and Supplies		3	
° Administration		2	
° Insurance		4	
Voyage Cost			30
° Port Charges		7	
- Harbour Dues	*		
- Handling	7		
° Seaway Tolls		13	
- Cargo	11		
- grt	1		
- Lockage	1		
° Pilotage Fees		1	
° Bunker Fuel		9	
TOTAL			100

*Less than one percent.

Exhibit A.9

Canadian-Built Lake/Ocean Bulker Sailing Times and Distances and Grain/Iron Ore Cost Allocation for Grain/U.S. Steel Mills Route

Port of Call	Distance (Statute Miles)	Time in Port and Sailing	
		Grain	Iron Ore
		Day(s)	Day(s)
Thunder Bay		1.64	
Steaming to Quebec	1372	5.17	
Quebec		1.54	
Steaming to Sept-Îles	331		1.00
Sept-Îles			1.21
Steaming to Cleveland	1015		4.05
Cleveland			0.45
Steaming to Thunder Bay	711	2.14	
Totals	3429	10.49	6.72
Percentage of Time		61%	39%
Vessel Cost Allocation	1986	$294617	$188362
	1991	$347308	$222049
Vessel Cost per Tonne	1986	$ 11.88	$7.60
(Cargo Capacity = 24800t)	1991	$ 14.00	$8.95

Exhibit A.10

Lake Self-Unloader Cost Per Voyage for Grain/U.S. Steel Mills Route

(Thunder Bay - Quebec - Sept-Îles - Cleveland - Thunder Bay = 17.9 Days)

	$1986 per Voyage		
Capital Charge			320,218
Operating Cost			191,497
° Crew Wages		98,079	
° Repairs and Maintenance		35,366	
° Stores and Supplies		15,010	
° Administration		16,998	
° Insurance		26,045	
Voyage Cost			161.452
° Port Charges		32,909	
- Harbour dues	909		
- Handling	32,000		
° Seaway Tolls		66,839	
- Cargo	54,967		
- grt	7,232		
- Lockage	4,640		
° Pilotage Fees		6,414	
° Bunker Fuel		55,291	
TOTAL			673,166

Exhibit A.11

Lake Self-Unloader Annual Cost Distribution for
Grain/U.S. Steel Mils Backhaul

(Thunder Bay - Quebec - Sept-Îles - Cleveland - Thunder Bay = 14.0 Voyages)

	1983 Cost in %		
Capital Charge			48
Operating Cost			28
° Crew Wages		15	
° Repairs and Maintenance		5	
° Stores and Supplies		2	
° Administration		3	
° Insurance		4	
Voyage Cost			24
° Port Charges		5	
- Harbour Dues	*		
- Handling	5		
° Seaway Tolls		10	
- Cargo	8		
- grt	1		
- Lockage	1		
° Pilotage Fees		1	
° Bunker Fuel		8	
TOTAL			100

*Less than one percent.

Exhibit A.12

Lake Self-Unloader Sailing Distances and Times and Grain/Iron Ore Cost Allocation for Grain/U.S. Steel Mills Route

Port of Call	Distance (Statute Miles)	Time in Port and Sailing	
		Grain	Iron Ore
		Day(s)	Day(s)
Thunder Bay		1.68	
Steaming to Quebec	1372	5.52	
Quebec		1.58	
Steaming to Sept-Îles	331		1.00
Sept-Îles			1.23
Steaming to Cleveland	1015		4.29
Cleveland			0.37
Sailing to Thunder Bay	711	2.14	
Totals	3429	10.93	6.89
Percentage of Time		61%	39%
Vessel Cost Allocation	1986	$410631	$262535
	1991	$473662	$302833
Vessel Cost Per Tonne	1986	$ 15.61	$9.98
(Cargo Capacity = 26300t)	1991	$ 18.01	$11.51

Exhibit A.13

Canadian-Built Lake/Ocean Self Unloader Cost Per Voyage for Grain/U.S. Steel Mills Route

(Thunder Bay - Quebec - Sept-Îles - Cleveland - Thunder Bay = 17.7 Days)

	$1986 per Voyage		
Capital Charge			248,927
Operating Cost			192,348
° Crew Wages		100,871	
° Repairs and Maintenance		37,181	
° Stores and Supplies		15,935	
° Administration		13,476	
° Insurance		24,866	
Voyage Cost			155,195
° Port Charges		32,993	
- Harbour dues	993		
- Handling	32,000		
° Seaway Tolls		64,376	
- Cargo	51,832		
- grt	7,904		
- Lockage	4,604		
° Pilotage Fees		6,739	
° Bunker Fuel		51,086	
TOTAL			596,469

Exhibit A.14

Canadian-Built Lake/Ocean Self-Unloader Annual % Cost Distribution for Grain/U.S. Steel Mills Route

(Thunder Bay - Quebec - Sept-Îles - Cleveland - Thunder Bay = 14.0 Voyages)

	1986 Cost in %		
Capital Charge			42
Operating Cost			32
° Crew Wages	17		
° Repairs and Maintenance	6		
° Stores and Supplies	3		
° Administration	2		
° Insurance	4		
Voyage Cost			26
° Port Charges		6	
- Harbour Dues	*		
- Handling	5		
° Seaway Tolls		11	
- Cargo	9		
- grt	1		
- Lockage	1		
° Pilotage Fees		1	
° Bunker Fuel		9	
TOTAL			100

*Less than one percent.

Exhibit A.15

Canadian-Built Lake/Ocean Self-Unloader Sailing Distances and Times and Grain/Iron Ore Cost Allocation for Grain/U.S. Steel Mills Route

Port of Call	Distance (Statute Miles)	Time in Port and Sailing	
		Grain	Iron Ore
		Day(s)	Day(s)
Thunder Bay		1.64	
Steaming to Quebec	1372	5.52	
Quebec		1.54	
Steaming to Sept-Îles	331		1.00
Sept-Îles			1.21
Steaming to Cleveland	1015		4.29
Cleveland			0.36
Steaming to Thunder Bay	711	2.14	
Totals	3429	10.84	
Percentage of Time		61%	39%
Vessel Cost Allocation	1986	$363846	$232623
	1991	$426454	$272651
Vessel Cost per Tonne	1986	$ 14.67	$9.38
(Cargo Capacity = 24800t)	1991	$ 17.20	$10.99

Appendix B

VESSEL COSTING MODEL

The following is a brief description of the Vessel Costing Model computer program and its operation. An example of the output from a run is given below.

Values from the data base stored in the model are used as base case parameters. Since the program is interactive the user is prompted to respond to many questions during execution.

To begin, the user is asked to choose between two cargoes: coal or grain. If coal is selected a choice must be made between 2 vessel types: lake self-unloader and lake/ocean self-unloader. If grain is selected an additional 2 vessels may be investigated: lake bulker and lake/ocean bulker.

Following vessel selection, if grain is the cargo then the user is prompted to select the route. The options are grain shuttle, grain-Canadian steel mills, and grain U.S. steel mills. Next, a choice can be made among several loading and unloading ports for grain and iron ore as applicable or the user may opt for the base case. If coal is the cargo then no base case is used. There is simply a choice among six loading and six unloading ports.

With route and port selection completed, the next option is to view all or part of the database associated with the particular run. The information is displayed in six separate sections in the following order:

- **Vessel Dimensions and Performance**
  - gross registered tonnage
  - length
  - breadth
  - depth
  - draft
  - cargo capacity
  - speed
  - fuel consumption in port and during navigation.

- **New Building Price and Financial Data**
  - vessel price
  - debt/equity ratio
  - cost of debt
  - cost of equity
  - corporate tax rate
  - weighted cost of capital net of tax
  - capital cost allowance
  - economic life

- **Annual Operating Cost**
  - crew wages
  - repairs and maintenance
  - stores and supplies
  - administration
  - insurance
  - total operating cost
  - annual operating days

- Fuel Price
  - marine diesel
  - engine fuel (heavy fuel)

- Port Time and Changes
  - harbour dues
  - loading/unloading rate
  - waiting time

- Seaway Tolls, Handling Cost and Canal Transit Times
  - grt toll on Welland and MLO
  - cargo toll on Welland and MLO
  - lockage fee on Welland
  - transit times for Welland and MLO
  - handling costs

- Cost Escalators
  - escalation period
  - - crew wages
  - repairs and maintenance
  - stores of supplies
  - administration
  - insurance
  - marine diesel
  - heavy fuel

Following the display, the user is asked whether any change(s) to the data base is/are required. If no change is required, the program will skip this section, and the computation will begin. Alternatively, if changes are required, the program will again display the base case data and allow the user to enter the new values. The types of data change that are permissible are the following:

- Vessel Price and Financial Conditions
  - vessel price
  - debt/equity ratio
  - cost of debt
  - cost of equity
  - risk premium
  - corporate tax rate
  - economic life
  - capital cost allowance

- Seaway Tolls
  - grt tolls
  - cargo toll
  - lockage fee

- Handling Cost

- Cost Escalator
  - escalation period
  - crew wages
  - repairs and maintenance

- stores of supplies
- administration
- insurance
- marine diesel
- heavy fuel

It is worth noting that the user can bypass any of these sections to arrive at the appropriate place for changing the data. Once the data change is completed, the program will begin the computations.

3. **Model Output**

Five output tables are provided at the end of the computation. The viewer is, however, requested to select one at a time. The types of output shown are as follows:

Summary of Data Base Changes. This is a summary of the data change(s) the user has made in the run. The table displays the new value as well as the old value (base case value). This output is highly useful as a check against incorrect input values.

Vessel Cost Per Voyage. This is a breakdown of 1986 and future year vessel cost in current dollars for the selected voyage. The table shows the following:

- **Routing**
- **Number of days required for the voyage**
- **Capital charge**
- **Operating Cost**
  - crew wages
  - repairs and maintenance
  - stores of supplies
  - insurance
  - administration
- **Voyage Cost**
  - port charge
  - harbour dues
  - handling cost
  - seaway tolls
  - grt
  - cargo
  - lockage
  - bunker fuel
- **Total Cost**

Vessel Cost Per Year. This is similar to the above, except that the results are shown on an annual basis. It also shows the number of voyages made in a Seaway season, instead of the number of days required for the voyage.

Vessel Cost Distribution. This table shows the cost breakdown in percentage terms. It is useful for identifying the significance of the various cost components.

Grain/Iron Ore Cost Allocation. This final table shows the vessel time allocated to grain and iron ore for the voyage. It also shows the vessel cost per tonne for grain and iron ore.

4. Further Runs

After viewing the results, the user is asked whether another run is required. If a new run is required the program will return to the beginning and repeat subsequent steps. If no further run is required, the program will terminate. As can be seen, any number of runs can be made to test a series of "what if" questions.

GREAT LAKES/ST. LAWRENCE SEAWAY VESSEL COSTING MODEL

Two cargos may be investigated: GRAIN (with or without Iron Ore backhaul) or COAL

Which cargo do you wish to investigate?

ENTER 1 for COAL or 2 for GRAIN

This model allows four types of lake vessels to be investigated. Only one vessel may be computed per run. The types of vessels are the following:

Vessel	Code
Lake Bulker	LB
Lake/Ocean Bulker	OB
Lake Self-Unloader	LS
Lake/Ocean Self-Unloader	OS

Which vessel do you wish to investigate? LB

Route Selection

Three basic types of voyage routing exist for the mainline grain movement:

- Grain Shuttle
- Canadian Steel Mills Backhaul
- U.S. Steel Mills Backhaul

Each type is described below and you are requested to select one for analysis. Each assumes a specific set of loading and unloading ports as the base case. You will have the option of changing the ports later on.

The GRAIN SHUTTLE is a grain voyage having no iron ore backhaul. The routing is:

Thunder Bay - Quebec - Thunder Bay

The Canadian Steel Mills backhaul is a grain voyage with a backhaul of iron ore unloaded at Hamilton. The routing is:

Thunder Bay - Quebec - Sept-Îles - Hamilton - Thunder Bay

The U.S. Steel Mills backhaul is a grain voyage with a backhaul of iron ore unloaded at a U.S. lower Great Lakes port. The routing is:

Thunder Bay - Quebec - Sept Îles - Cleveland - Thunder Bay

Enter the type of voyage you want to analyze: (1=GRAIN SHUTTLE, 2=CANADIAN STEEL MILLS, 3=U.S. STEEL MILLS): ? 3

Port Changes for Grain/U.S. Mills Route

Do you intend to change ports (Y/N) ? Y

The assumed routing is Thunder Bay - Quebec - Sept Îles - Cleveland and Thunder Bay.

The DEFAULT GRAIN LOADING PORT is Thunder Bay. You may change it to one of the following:

Port	Number
Montreal	1
Sorel	2
Trois Rivières	3
Baie Comeau	5
Port Cartier	6
Midland	7
Goderich	8
Port Colbourne	9
Prescott	10
Halifax	11

Enter Port Number (0 = Thunder Bay) ? 5

The assumed grain unloading port is Quebec. You may change it to the following:

Port	Number
Montreal	1
Sorel	2
Trois Rivières	3
Baie Comeau	5
Port Cartier	6
Midland	7
Goderich	8
Port Colbourne	9
Prescott	10
Halifax	11

Enter Port Number (0 = Quebec) ? 5

The assumed iron ore loading port is Sept-Îles. You may change it to one of the following:

Port	Number
Port Cartier	1
Point Noire	2

Enter Port Number (0 = Sept-Îles) ? 2

The assumed iron ore unloading port is Cleveland. You may change it to one of the following:

Port	Number
Ashtabula	3
Chicago	5
Detroit	6

Enter Port Number (0 = Cleveland) ? 3

Data Base Display

The Lake Bulker has been selected for analysis. This is a Canadian Built ship. The route you have chosen is GRAIN/U.S. MILLS. The navigation season on the lakes is 260 days.

You can now view the vessel and route data. Once you have completed viewing, you will have the opportunity to change the data for your analysis. To view the data base, enter **Y**, or to bypass it, enter **N**. - ? **Y**

The first display is Vessel Dimension & Performance. Do you wish to view it (Y/N) ? **Y**

Vessel Dimensions and Performance information for Lake Bulker.

Gross Registered Tonnage	= 20200
Length (m.)	= 222.50
Breadth (m.)	= 23.00
Depth (m.)	= 12.80
Draught Loaded in Seaway (m.)	= 7.92
Draught Empty in Seaway (m.)	= 6.00
Cargo Capacity (tonnes)	= 27500
Speed Empty in Open Water (knots)	= 11.5
Speed Loaded in Open Water (knots)	= 10.5
Fuel Consumption Rate in Port (tons Marine Diesel/Day)	= 2.10
Generator Fuel Consumtpion Rate in Navigation (tons of Marine Diesel Fuel/Day)	= 5.43
Main Engine Fuel Consumption Rate in Navigation (tons of Main Engine Fuel/Day)	= 14.86
Crew Complement	= 24
Annual Operating Days	= 260

Do you with to view Vessel Price and Financial Information (Y/N) ? Y

Newbuilding Price and Financial Information

Newbuilding Price	=	$29000000
(This price representative of recently built Great Lake Ships (1983)		
Debt-Equity Financing	=	0.80/0.20
Cost of Debt	=	9.0% per annum
Average Cost of Equity	=	18.0% per annum
Equity Risk Premium	=	70.0% per annum
Marginal Cost of Equity	=	30.6% per annum
Corporate Tax Rate	=	50.0% per annum
Weighted Cost of Capital After Tax	=	9.7% per annum
Capital Cost Allowance	=	1/6, 1/3, 1/3, 1/6
Economic Life	=	25 years

Next Display is Annual Operating Cost. Do you wish to view it (Y/N) ? Y

Annual Operating Cost (1986 $)

Crew Wages	=	$1227000
Repairs and Maintenance	=	470000
Stores and Supplies	=	176000
Administration	=	234000
Insurance	=	32100
Total Operating Cost	=	$2428000
Annual Operating Days	=	260

Next Display is Voyage Data. Do you want to view it (Y/N) ? Y

Voyage Cost Data Display

1986 Fuel Price Data

Marine Diesel ($/ton)	=	182.73
Main Engine Fuel	=	120.00

Next Display is Port Characteristics. Do you wish to view it (Y/N) ? Y

Port Data for the Grain/U.S. Mills Route

Grain Loading Port of Milwaukee

Habour Dues ($/grt)	=	0.0000
Waiting Time (days)	=	0.70
Loading Rate (tonnes/hr.)	=	800

Grain Unloading Port of Baie Comeau

Harbour Dues ($/grt)	=	0.0347
Waiting Time (days)	=	0.90
Unloading Rate (tonnes/hr.)	=	1400

Iron Ore Loading Port of Pointe Noire

Harbour Dues ($/grt)	=	0.0347
Waiting Time (days)	=	0.30
Loading Rate (tonnes/hr.)	=	4300

Iron Ore Unloading Port of Ashtabula

Harbour dues ($/grt)	=	0.0000
Waiting time (days)	=	0.35
Unloading rate (tonnes/hr.)	=	2500

Next Display is Seaway Tolls, Canal Times and Handling Cost

Do you want to view it (Y/N) ? Y

Seaway Tolls, Time in Canals and Handling Cost Data

Seaway Tolls

GRT Toll on Welland	= $	0.08/grt
Grain Cargo Toll on Welland	= $	0.36/grt
Ore Cargo Toll on Welland	= $	0.36/tonne
Lockage Toll on Welland for Loaded Vessel	= $	290.0/lock
Lockage Toll on Welland for Empty Vessel	= $	215.0/lock
GRT Toll on MLO	= $	0.08/grt
Grain Cargo Toll on MLO	= $	0.52/tonne
Ore Cargo Toll on MLO	= $	0.85/tonne

Transit Times for St. Lawrence Seaway

Welland Transit Time	=	0.50 day
MLO Transit Time	=	1.00 day

Handling Costs (berthage, stevedoring, agency, overtime, tug):

Handling Cost	= $	32000/voyage

Next Display is Cost Escalators. Do you want to view them (Y/N) ? Y

Cost Escalators to 1991

Item	Escalator
Operating Cost:	
Crew Wages and Salaries	1.060
Repairs and Maintenance	1.080
Stores and Supplies	1.060
Administration	1.060
Insurance	1.060
Voyage Cost:	
Marine Diesel	1.040
Heavy Fuel	1.040
Handling	1.060
Harbour Dues	1.028
Pilotage	1.028
Seaway GRT Toll	1.028
Lockage Toll	1.028
Cargo Toll	1.028

This completes data base display. Enter **XX** to continue. ? **XX**

Data Base Changes

You now have the option of modifying the data base. If you decide to modify the data base, the new entries will become input to the computation. However, if you decide not to, the default values will apply:

Do you wish to change the data base (Y/N) ? Y

Financial Data and Lake Navigation Season Changes

Do you intend to change data (Y/N)? Y

Newbuilding Price	= $29000000
New Value (0 = Default)	?30000000
Debt Financed Portion	= 0.80
New Value (0 = Default)	?0.75
Equity Risk Premium	= 0.70
New Value (0 = Default)	?0
Corporate Tax Rate	= 0.50
New Value (0 = Default)	?0
Economic Life (Years)	= 25
New Value (0 = Default)	?30
CapitalCost Allowance	= 1/6,1/3,1/3,1/6
New Value (DB for declining balance or CCA for Fast Depreciation)	?0
Current Rate of Decline	= 0.04
New Rate of Decline (0 = Default)	?0
Lake Navigation Season	= 260 days
New Value (0 = Default)	?265

Do you intend to change Voyage Data (Y/N) ? Y

Changes to Seaway Tolls

Do you wish to change Seaway Tolls (Y/N) ? Y

GRT Toll on Welland ($/GRT)	=	0.08
New Value (0 = same as above)	?	0.085
Cargo Toll for Grain on Welland ($/tonne)	=	0.36
New Value (0 = same as above)	?	0.39
Cargo Toll for Ore on Welland ($/tonne)	=	0.36
New Value (0 = same as above)	?	0.39
Lockage Toll on Welland for Loaded Vessel ($/Lock)	=	290.0
New Value (0 = same as above)	?	300.0
Lockage Toll on Welland for Vessel in Vallast ($/Lock)	=	215.0
New Value (0 = same as above)	?	225.0
GRT Toll on MLO ($/GRT)	=	0.08
New Value (0 = same as above)	?	0.0865
Cargo Toll for Grain on MLO ($/tonne)	=	0.52
New Value (0 = same as above)	?	0.55
Cargo Toll for Ore on MLO ($/tonne)	=	0.85
New Value (0 = same as above)	?	0.90

Handling Cost Changes (Overtime, Stevedoring, Agency, Berthage, Tug)

Do you wish to change Handling Cost (Y/N) ? Y

Handling Cost	=	32000
New Value (0 = same as above)	?	30000

Cost Escalator Changes

Do you wish to change Operating Cost Escalators (Y/N) ? Y

Cost Escalation Period (years)	=	5
New Value (0 = same as above)	?	1
Crew Wage Escalator	=	1.060
New Value (0 = same as above)	?	0
Repairs and Maintenance	=	1.080
New Value (0 = same as above)	?	0
Stores and Supplies Escalator	=	1.060
New Value (0 = same as above)	?	0
Administration Escalator	=	1.060
New Value (0 = same as above)	?	0
Insurance Escalator	=	1.060
New Value (0 = same as above)	?	0
Price Escalator for Marine Diesel	=	1.040
New Escalator (0 = same as above)	?	0
Price Escalator for Main Engine Fuel	=	1.040
New Escalator (0 = same as above)	?	0
Handling Cost Escalator	=	1.060
New Escalator (0 = same as above)	?	0
Harbour Dues Escalator	=	1.028
New Escalator (0 = same as above)	?	0
Seaway GRT Toll Escalator	=	1.028
New Escalator (0 = same as above)	?	0
Seaway Lockage Toll Escalator	=	1.028
New Escalator (0 = same as above)	?	0
Seaway Cargo Toll Escalator	=	1.028
New Escalator (0 = same as above)	?	0

The Lake Bulker is now leaving Milwaukee to begin her Grain/U.S. Mills voyage. It will take a few seconds before she returns to port.

Printing Menu

The Canadian built Lake Bulker has now completed the Grain/U.S. Mills voyage. You can view the results by selecting from the menu below.

Summary of Data Base Changes	—	AA
Vessel Cost per Voyage	—	BB
Vessel Cost Per Year	—	CC
Vessel Cost Distribution per Year (%)	—	DD
Grain/Iron Ore Cost Allocation	—	EE

What is your Choice? AA
Data Base Changes

	Base Case Value	New Value
Vessel Price & Financing:		
Newbuilding Price	$29000000	$30000000
Debt Financing	80%	75%
Cost of Debt	9%	8%
Weighted Cost of Capital	9.7%	10.7%
Economic Life	25 years	30 years
Lake Navigation Season	260 days	265 days
Cost Escalators:		
Cost Escalation Period	5 years	1 year
Seaway Tolls:		
GRT Toll on Welland	0.08	0.09
Grain Toll on Welland	0.36	0.39
Ore Toll on Welland	0.36	0.39
Lockage Fee for Loaded Vessel	290.0	300.0
Lockage Fee for Empty Vessel	215.0	225.0
GRT Toll on MLO	0.08	0.09
Grain Toll on MLO	0.52	0.55
Ore Toll on MLO	0.85	0.90
Handling Cost:		
Handling (stevedoring, etc.)	32000	30000

Enter P to return to Printing Menu or E to Exit?

Lake Bulker Cost per Voyage for Grain/U.S. Mills Route

(Milwaukee - Baie Comeau - Pointe Noire - Ashtabula - Milwaukee = 18.2 days)

	1986$ per Voyage		1987$ per Voyage	
Capital Charge		280745		280745
Operating Cost		166493		177128
°Crew Wages	84138		89186	
°Repairs and maintenance	32229		34807	
°Stores and Supplies	12069		12793	
°Administration	16046		17009	
°Insurance	22012		23332	
Voyage Cost		148590		154193
°Port Charges	31402		33242	
-Harbour Dues	1402		1442	
-Handling	30000		31800	
°Seaway Tolls	72993		75062	
-Cargo	61325		63063	
-GRT	6868		7063	
-Lockage	4800		4936	
°Pilotage Fees	6259		6436	
°Bunker Fuel	37936		39454	
TOTAL		595828		612066

Enter P to return to Printing Menu or E to Exit?

Lake Bulker Cost Per Annum for Grain/U.S. Mills Route

(Milwaukee - Baie Comeau - Pointe Noire - Ashtabula - Milwaukee = 14.0 Voyages)

	1986$ per Annum		1987$ per Annum	
Capital Charge		3930431		3930431
Operating Cost		2330908		2479786
°Crew Wages	1177934		1248610	
°Repairs and Maintenance	451205		487302	
°Stores and Supplies	168962		179100	
°Administration	224643		238121	
°Insurance	308164		326654	
Voyage Cost		2080258		2158702
°Port Charges	439626		465382	
-Harbour Dues	19626		20183	
-Handling	420000		445200	
°Seaway Tolls	1021902		1050863	
-Cargo	858550		882881	
-GRT	96152		98877	
-Lockage	67200		69104	
°Pilotage Fees	87624		90107	
°Bunker Fuel	531106		552350	
TOTAL		8341597		8568920

Enter P to return to Printing Menu or E to Exit?

Lake Bulker Annual Cost Distribution for Grain/U.S. Mills Route

(Milwaukee - Baie Comeau - Pointe Noire - Ashtabula - Milwaukee = 14.0 Voyages)

	1986$ Cost in %			1987$ Cost in %		
Capital Charge			47			46
Operating Cost			28			29
°Crew Wages		14			15	
°Repairs and Maintenance		5			6	
°Stores and Supplies		2			2	
°Administration		3			3	
°Insurance		4			4	
Voyage Cost			25			25
°Port Charges			5			5
-Harbour Dues	0			0		
-Handling	5			5		
°Seaway Tolls		12			12	
-Cargo	10			10		
-GRT	1			1		
-Lockage	1			1		
°Pilotage Fees		1			1	
°Bunker Fuel		6			6	
TOTAL			100			100

Enter P to return to Printing Menu or E to Exit?

Sailing Distances and Times - Grain/Iron Ore Cost Allocation

Port of Call	Distance (Statute Miles)	Time in Port and Sailing	
		Grain	Iron Ore
		Day(s)	Day(s)
Milwaukee		2.13	
Steaming to Baie Comeau	1578	6.23	
Baie Comeau		1.72	
Steaming to Pointe Noire	117		0.37
Pointe Noire			0.57
Steaming to Ashtabula	955		4.09
Ashtabula			0.81
Steaming to Milwaukee	718	2.26	
TOTALS	3368	12.34	5.83
Percentage of Time		68%	32%
Vessel Cost Allocation	1986	$405163	$190665
	1987	$416205	$195861
Vessel Cost Per Tonne	1986	$ 14.73	$6.93
(Cargo Capacity = 27500t)	1987	$ 15.13	$7.12

Enter P to return to Printing Menu or E to Exit?

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